



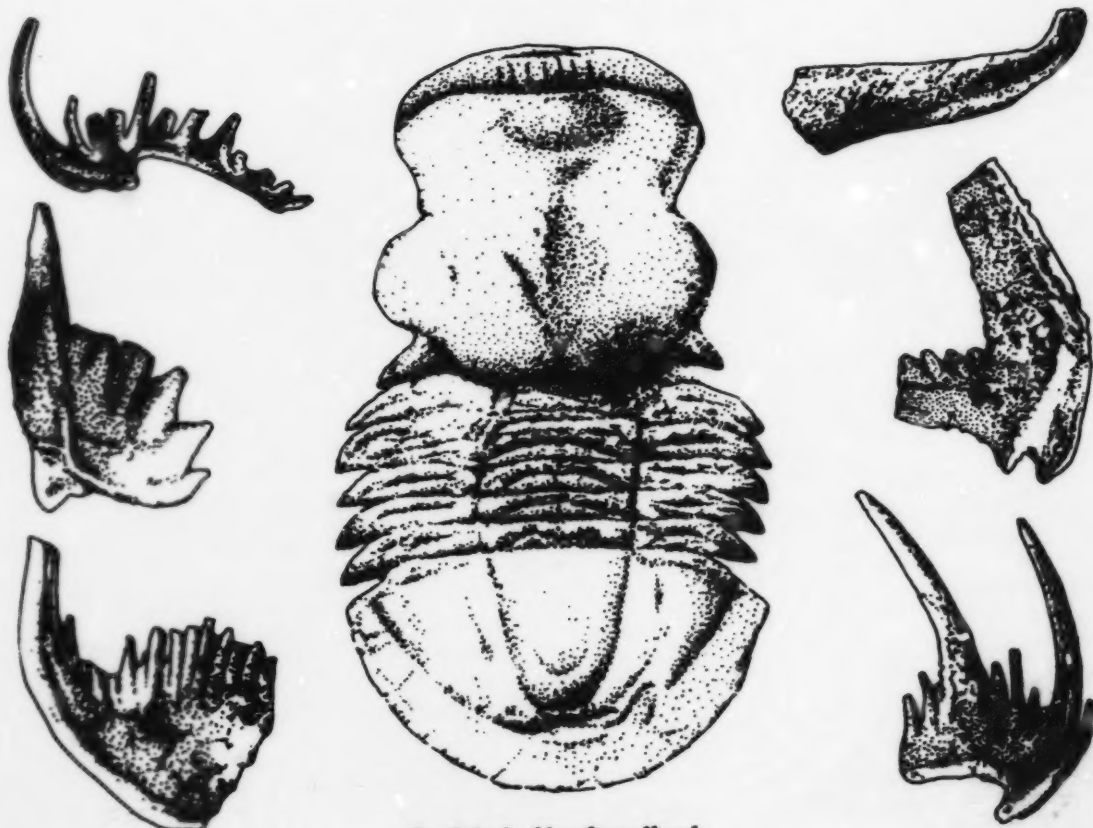
Mineral Development Division
Department of Mines and Energy
Government of Newfoundland and Labrador

**FOSSILS OF NORTHWESTERN NEWFOUNDLAND
AND SOUTHEASTERN LABRADOR:
CONODONTS AND TRILOBITES**

by

Svend Stouge and W. Douglas Boyce

Report 83-3



**St. John's, Newfoundland
1983**

Editor R.V. Gibbons

Review Geologist Jane Murray

Copy Editors Phil Saunders
Doug Boyce

Text editing and typesetting

T. Parsons
B. French
D. Downey

Typing

W. Martin
E. Fost

Drafting Supervisor

K. Byrne

Drafting

D. Leonard
T. Paltanavage
A. Billard

Acknowledgements

This work was done under the Canada/Newfoundland Mineral Development Subsidiary Agreement (1976-1982) by contributions from the Government of Newfoundland and Labrador (10 percent) and from the Departments of Regional Economic Expansion (45 percent) and Energy, Mines and Resources (45 percent) of the Government of Canada.

Cover drawn by Dave Leonard shows the trilobite "*Parabellefontia*" sp. nov. and, clockwise from the top right, the conodonts *Macerodus diana* Fähræus and Nowlan, *Oepikodus communis* (Ethington and Clark), *Erraticodon balticus* Dzik, *Belodella* sp., *Bergstroemognathus extensus* Serpagli, and *Cordylodus? horridus* Barnes and Poplawski.

Publications of the Mineral Development Division are available through the Publications and Information Section, Mineral Development Division, Department of Mines and Energy, P.O. Box 4750, St. John's, Newfoundland A1C 5T7
Telephone: (709) 737-3159
Telex: 016-4724



**Mineral Development Division
Department of Mines and Energy
Government of Newfoundland and Labrador**

**FOSSILS OF NORTHWESTERN NEWFOUNDLAND
AND SOUTHEASTERN LABRADOR:
CONODONTS AND TRILOBITES**

by

Svend Stouge and W. Douglas Boyce

Report 83-3

"THE BUG BOOK"

**St. John's, Newfoundland
1983**



Foreword

This guide is primarily intended for the use of field geologists in western Newfoundland. However, nonprofessionals with an interest in collecting and identifying fossils may also find it useful.

Unless the lithostratigraphic succession is well established, it is not always possible to distinguish units of similar lithology in the field except by means of fossils. This is particularly true of rubbly weathering, massive bedded, bioturbated limestones that occur in formations of different ages in the carbonate sequences of western Newfoundland. These units include the Middle Cambrian March Point Formation, the Early Ordovician Boat Harbour and Catoche Formations, and the Middle Ordovician Table Head Formation. They resemble each other lithologically but contain distinctive faunas.

This guide is divided into three chapters. The first chapter (by Stouge) outlines the stratigraphy of the Cambrian-Ordovician platformal sequence of southeastern Labrador and the northwestern part of the Great Northern Peninsula. The next two chapters describe the biostratigraphy of (1) conodonts from the upper St. George Group and the Table Head Formation (Chapter 2 by Stouge) and (2) the Cambrian to Early Ordovician trilobite faunal succession (Chapter 3 by Boyce). Both chapters describe collection techniques and means of preparation of the samples and specimens in the laboratory. All three chapters provide references to papers considered useful for additional, more detailed information.

This guide illustrates the current knowledge of the fossil groups involved. The fossil names are not meant to be taxonomically rigorous as current research may change some of the names applied herein. Only those fossils which are of stratigraphic significance, or are illustrative of the occurrence of a particular assemblage, are depicted.

Each chapter is an independent entity for which each author is individually responsible. Both authors have alternately coordinated and assembled the manuscript.

Acknowledgements

I. Knight and the geological and supervisory staff of the Newfoundland Department of Mines and Energy, Mineral Development Division, are thanked for their enthusiasm and support since 1976 when the authors' work began in western Newfoundland. Dr. C.H. Kindle provided access to his outstanding private collection of western Newfoundland trilobites. Drs. R.A. Fortey and A.R. Palmer freely provided Boyce with unpublished information and beneficial discussions on trilobites.

Figures and manuscripts were drafted and processed by the staff of the Mineral Development Division, Newfoundland Department of Mines and Energy. Editing and scientific reviews were done by geologists of the Mineral Development Division. C. Emerson, Biology Department, Memorial University of Newfoundland provided technical assistance for the SEM photography. W. Marsh, Department of Earth Sciences, Memorial University of Newfoundland, provided the plates. Dave Leonard drafted the cover. Their help is greatly appreciated. Special thanks go to Dr. R. Ludvigsen (University of Toronto) who reviewed the manuscript and suggested several improvements.



TABLE OF CONTENTS

	<u>PAGE</u>
Foreword.....	1
Acknowledgments.....	1
 CHAPTER 1: STRATIGRAPHY OF THE PLATFORMAL SEQUENCE OF THE GREAT NORTHERN PENINSULA.....	1
Stratigraphy.....	1
References.....	2
 CHAPTER 2: CONODONTS OF THE UPPER ST. GEORGE GROUP (CANADIAN-WHITEROCKIAN) AND THE TABLE HEAD FORMATION (WHITEROCKIAN).....	5
Introduction.....	5
Environmental control of the conodont faunas.....	5
Conodont faunas of the St. George Group and the Table Head Formation.....	5
Conodont sample collection procedure	6
Simple conodont processing procedure.....	15
Precautions.....	15
Identification.....	15
References.....	15
 CHAPTER 3: CAMBRIAN-ORDOVICIAN TRILOBITES OF SOUTHEASTERN LABRADOR AND THE GREAT NORTHERN PENINSULA.....	17
Introduction.....	17
Environmental control of the trilobite faunas.....	17
Trilobite faunas of the platformal sequence.....	19
Trilobite collection procedure.....	21
Identification.....	21
References.....	21
Storage locations of illustrated specimens.....	23



LIST OF ILLUSTRATIONS

FIGURES

PAGE

1.1. Geological elements of western Newfoundland.....	vi
1.2. Cambrian-Ordovician stratigraphy of southeastern Labrador and the Great Northern Peninsula.....	1
2.1. Geological elements and conodont localities of the Great Northern Peninsula.....	6
2.2. Ranges of selected Early-Middle Ordovician conodont species on the Great Northern Peninsula.....	7
2.3. Conodont morphologic nomenclature.....	14
3.1. Trilobite morphologic nomenclature.....	18
3.2. Ranges of selected Cambrian trilobite species from southeastern Labrador and the Great Northern Peninsula.....	19
3.3. Ranges of selected Early-Middle Ordovician trilobite species from the Great Northern Peninsula.....	20

Table

2.1. Laboratory procedure for conodont processing.....	8
--	---

Plates

1. Conodonts from the Boat Harbour and Catoche Formations.....	25
2. Conodonts from the Boat Harbour and lower Catoche Formations.....	27
3. Conodonts from the Boat Harbour, Catoche, Aguathuna and Table Head Formations.....	29
4. Conodonts from the Catoche, Aguathuna and lower Table Head Formations.....	31
5. Conodonts from the Aguathuna and lower Table Head Formations.....	33
6. Conodonts from the Table Head Formation.....	35
7. Conodonts from the Table Head Formation.....	37
8. Trilobites from the Forteau, Hawke Bay and March Point Formations.....	39
9. Trilobites from the March Point Formation.....	41
10. Trilobites from the March Point Formation.....	43
11. Trilobites from the March Point and Petit Jardin Formations.....	45
12. Trilobites from the Petit Jardin and Boat Harbour Formations.....	47
13. Trilobites from the Boat Harbour and Catoche Formations.....	49
14. Trilobites from the Boat Harbour and Catoche Formations.....	51
15. Trilobites from the Boat Harbour and Catoche Formations.....	53
16. Trilobites from the Boat Harbour and Catoche Formations.....	55

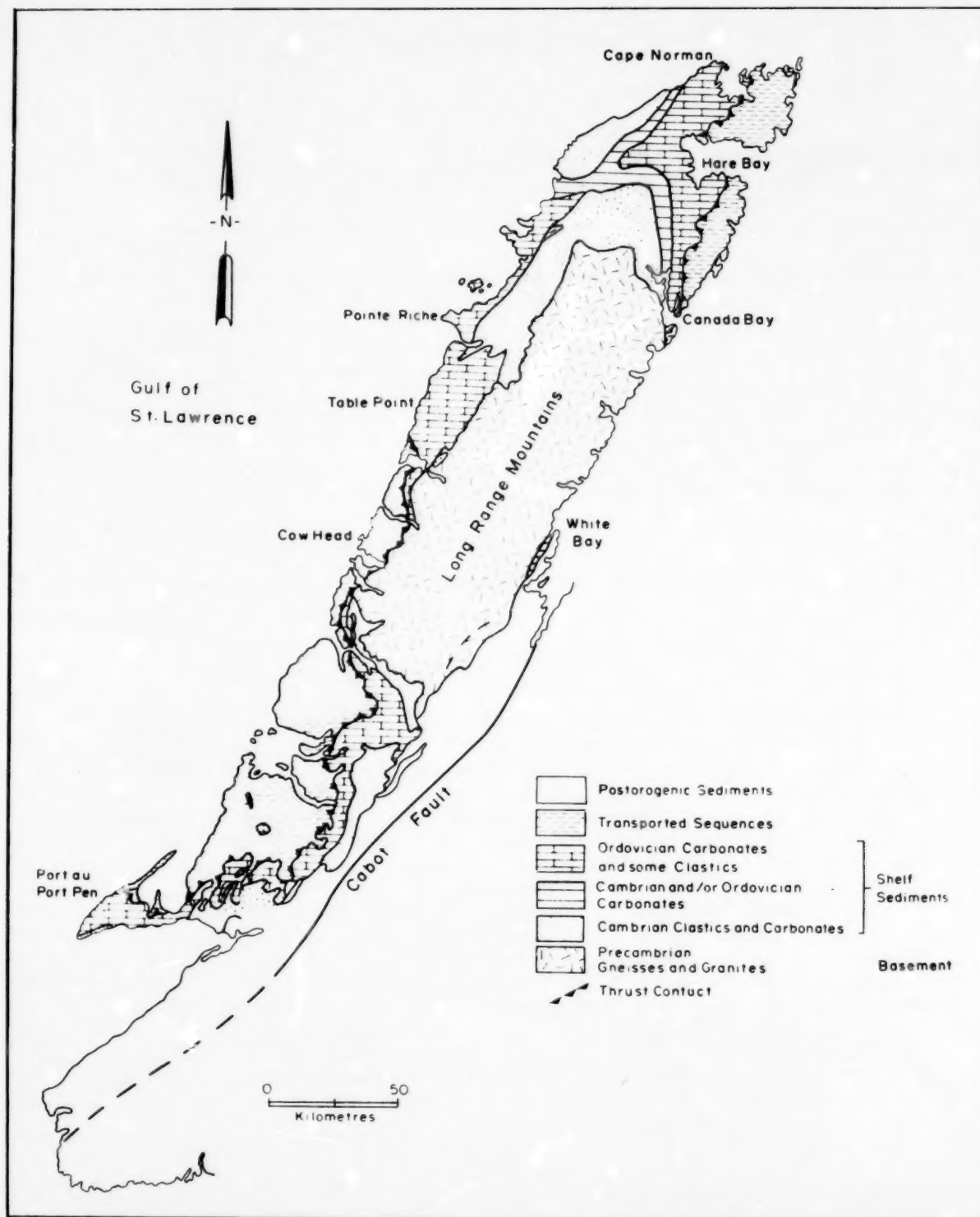


FIGURE 1.1. Geological elements of western Newfoundland.

CHAPTER 1

STRATIGRAPHY OF THE PLATFORMAL SEQUENCE OF SOUTHEASTERN LABRADOR AND THE GREAT NORTHERN PENINSULA

STRATIGRAPHY

The geological elements of western Newfoundland (Port au Port and Great Northern Peninsulas) are shown in Figure 1.1. The Cambrian-Ordovician carbonate rocks of southeastern Labrador and the Great Northern Peninsula are included in the Labrador, (informal) Port au Port, and St. George Groups and the Table Head Formation (Knight, 1978, 1980b; Klappa *et al.*, 1980; Stouge, 1981, 1982) (Figure 1.2). The stratigraphy is briefly outlined below. For details, the reader should refer to James and Kobluk (1978), James *et al.* (1980), Kluyver (1975), Knight (1977, 1978, 1980a & b, 1983), Schuchert and Dunbar (1934), Snow and Knight (1979), Knight and Saltman (1980), Klappa *et al.* (1980), Stouge (1980a, 1981, 1982), and Stouge and Godfrey (1982).

The Labrador Group (Lower Cambrian) is divided into the following formations, in ascending order (Figure 1.2): the Bradore Formation, mainly consisting of red arkosic sandstones; the Forteau Formation, consisting of biohermal limestones, bedded carbonates and shales; and the Hawke Bay Formation, consisting of white and reddish quartz sandstones interbedded with green shales. The informal Port au Port group (Middle to Upper Cambrian) is divided into the March Point and Petit Jardin Formations. The March Point Formation consists of bioturbated blue-gray limestones; the Petit Jardin Formation is composed of yellowish weathering, pale gray dolostones with prominent stromatolite horizons.

The St. George Group (Lower to Middle Ordovician) is divided into the following formations (Knight, 1980b, 1983; Stouge, 1982) in ascending order (Figure 1.2): the Watts Bight Formation

SYSTEM	SERIES	GROUP	FORMATION	MEMBER
ORDOVICIAN	MIDDLE		TABLE HEAD	UPPER
				MIDDLE
				LOWER
	LOWER	ST. GEORGE	AGUATHUNA	
			CATOCHE	UPPER
				LAIGNET POINT
				LOWER
			BOAT HARBOUR	UPPER
				LOWER
			WATTS BIGHT	
	?	?		
CAMBRIAN	UPPER	PORT AU PORT	PETIT JARDIN	CHERTY DOLOMITE
				UPPER DOLOSTONE
				MIDDLE STROMATOLITE
				LOWER DOLOSTONE
	MIDDLE		MARCH POINT	
	LOWER	LABRADOR	HAWKE BAY	
			FORTEAU	
			BRADORE	

FIGURE 1.2. Cambrian-Ordovician stratigraphy of southeastern Labrador and the Great Northern Peninsula.

consisting of massively bedded, dark gray to black dolostones; the informal Boat Harbour formation, consisting of a lower sequence of variegated dolostones, minor limestones and secondary dolostones and an upper sequence of bedded limestones and stromatolite mounds; and the Catoche Formation, consisting of rubbly, well bedded limestones. The middle part of the Catoche Formation is called the Laignet Point Member. The topmost limestones of the Catoche Formation have been extensively replaced by secondary dolostones, which have been called 'pseudobreccias' (Cumming, 1968; Collins and Smith, 1975) and "Diagenetic Carbonates" (Knight, 1977, 1978, 1980b). The uppermost part

of the St. George Group consists of bedded dolostones and dolomitic shales and is informally called the Aguathuna formation (James *et al.*, 1980; Pratt and James, 1982).

The Table Head Formation has been divided into three members (Schuchert and Dunbar, 1934; Whittington and Kindle, 1963; Stouge, 1980a, 1981) (Figure 1.2). The lower member consists of massively bedded, rubbly, blue-gray limestones; the middle member consists of thinly bedded limestones and shales; and the upper member consists of graptolitic shales. Klappa *et al.* (1980) recently revised the stratigraphy of the Table Head Formation for the southern part of the Great Northern Peninsula. They erected the Table Head Group and divided the sequence into four formations, namely, the Table Point Formation (formerly the lower member), the Table Cove Formation (equivalent to the middle member), the Black Cove Formation (equivalent to the upper member), and the Cape Cormorant Formation, which is new. This guide is concerned with fossils from only the lower and middle members, which are not assigned formational status.

In general, the Cambrian-Ordovician carbonate succession reflects the response of sedimentation on the platform to a number of major transgressive and regressive cycles. Thickly bedded, bioturbated and fossiliferous limestones were deposited in shallow-water, open-marine environments. These limestones represent transgressions. They are overlain by limestones and dolostones which were deposited in shallow-water, near-shore environments. These rocks represent the succeeding regressions.

Three transgressive-regressive cycles have been recognized in the Lower-Middle Ordovician rocks (Knight, 1980b; Stouge, 1980a, b, c, 1982). The first cycle involves the Watts Bight and Boat Harbour Formations. The second cycle comprises the Catoche and

Aguathuna Formations. The third cycle was initiated with the deposition of the Table Head Formation but was not completed (Stouge, 1982).

Disconformities mark the regressive stages. The first cycle is marked by an areally extensive, cherty "pebble bed" near the top of the Boat Harbour formation (Knight, 1978; Boyce, 1979; Stouge, 1981, 1982). The second disconformity is marked by a reddish breccia bed and, locally, an erosion surface. This breccia bed/erosion surface can be traced widely throughout western Newfoundland (Stouge, 1982) near or at the top of the dolostones of the Aguathuna formation below the Table Head Formation.

REFERENCES

- Boyce, W.D.
1979: Further developments in western Newfoundland Cambro-Ordovician biostratigraphy. In Report of Activities for 1978. Edited by R. V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 79-1, pages 7-10.
- Collins, J.A. and Smith, L.
1975: Zinc deposits related to diagenesis and intrakarstic sedimentation in the Lower Ordovician St. George Formation, western Newfoundland. Bulletin of Canadian Petroleum Geology, volume 23, pages 393-427.
- Cumming, L. M.
1968: St. George - Table Head disconformity and zinc mineralization, western Newfoundland. Canadian Institute of Mining and Metallurgy Bulletin, volume 61, pages 712-721.
- James, N.P. and Kobluk, D.R.
1978: Lower Cambrian patch reefs and associated sediments: southern Labrador, Canada. Sedimentology, volume 25, pages 1-35.

James, N.P., Klappa, C.F., Skevington, D. and Stevens, R.K.

1980: Cambro-Ordovician of West Newfoundland - Sediments and Faunas. Geological Association of Canada - Mineralogical Association of Canada, Field Guide Manual No. 13, 88 pages.

Klappa, C.F., Opalinski, P.R. and James, N.P.

1980: Middle Ordovician Table Head Group of western Newfoundland: a revised stratigraphy. Canadian Journal of Earth Sciences, volume 17, pages 1007-1019.

Kluyver, H.M.

1975: Stratigraphy of the Ordovician St. George Group in the Port-Au-Choix area, western Newfoundland. Canadian Journal of Earth Sciences, volume 12, pages 589-594.

Knight, I.

1977: Cambro-Ordovician platformal rocks of the Northern Peninsula, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 77-6, 27 pages.

1978: Platformal sediments on the Great Northern Peninsula: Stratigraphic studies and geological mapping of the North St. Barbe District. In Report of Activities for 1977. Edited by R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-1, pages 140-150.

1980a: Geological mapping of parts of the Eddies Cove, Salmon River and adjacent map areas. In Current Research. Edited by C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-1, pages 1-9.

1980b: Cambro-Ordovician carbonate stratigraphy of western Newfoundland; sedimentation, diagenesis and zinc-lead mineralization. Newfoundland

Department of Mines and Energy, Mineral Development Division, Open File NFLD. 1154, 43 pages.

1983: Geology of Cambro-Ordovician Rocks in Parts of the Castors River, St. John Island and Port Saunders Map Sheets. In Current Research. Edited by M.J. Murray, P.D. Saunders, W.D. Boyce and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 1-10.

Knight, I. and Saltman, P.

1980: Platformal rocks and geology of the Roddickton map area, Great Northern Peninsula. In Current Research. Edited by C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-1, pages 10-28.

Pratt, B.R. and James, N.P.

1982: Cryptalgal-metazoan bioherms of early Ordovician age in the St. George Group, western Newfoundland. Sedimentology, volume 29, number 4, pages 543-569.

Schuchert, C. and Dunbar, C.O.

1934: Stratigraphy of western Newfoundland. Geological Society of America, Memoir 1, 123 pages.

Snow, G. and Knight, I.

1979: Geological mapping of the carbonates of the Brig Bay map area, Newfoundland. In Report of Activities for 1978. Edited by R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 79-1, pages 1-6.

Stouge, S.

1980a: Conodonts of the Table Head Formation (Middle Ordovician); western Newfoundland. Unpublished Ph.D. thesis, Memorial University of Newfoundland, St. John's, 413 pages.

1980b: Lower and Middle Ordovician conodonts from central Newfoundland and their correlatives in western Newfoundland. *In* Current Research. Edited by C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-1, pages 134-142.

1980c: Correlation and timing of the migration of conodont faunas from the central Newfoundland limestone deposits onto the western platform. Geological Association of Canada and Mineralogical Association of Canada, Joint Annual Meeting, 1980, Halifax. Program with abstracts, volume 5, page 83.

1981: Cambrian-Middle Ordovician stratigraphy of Salmon River Region, Southwest Hare Bay, Great Northern Peninsula. *In* Current Research. Edited by C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of

Mines and Energy, Mineral Development Division, Report 81-1, pages 1-16.

1982: Preliminary conodont biostratigraphy and correlation of Lower to Middle Ordovician carbonates of the St. George Group, Great Northern Peninsula, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-3, 59 pages.

Stouge, S. and Godfrey, S.

1982: Geology of the area southwest of Hare Bay, Great Northern Peninsula. *In* Current Research. Edited by C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-1, pages 1-21.

Whittington, H.B. and Kindle, C.H.

1963: Middle Ordovician Table Head Formation, western Newfoundland. Geological Society of America Bulletin, volume 78, pages 745-758.

CHAPTER 2

CONODONTS OF THE UPPER ST. GEORGE
GROUP (CANADIAN-WHITEROCKIAN)
AND THE TABLE HEAD FORMATION
(WHITEROCKIAN)INTRODUCTION

Conodonts are minute toothlike microfossils that may be cone-; bar-; blade- or platform-shaped. They consist of calcium phosphate. They range in size from less than 0.1 mm to more than 4.0 mm. Conodonts, when unaltered, are translucent amber-brown; when altered, they range in color from dark-brown, gray, black to white (Epstein *et al.*, 1977).

Despite the lack of knowledge concerning the nature, biologic affinities and function of conodonts, it has been repeatedly demonstrated that they are one of the most useful and sensitive fossil groups for biostratigraphic zonation and correlation.

Conodont determinations may be valuable at all stages of geological work, whether reconnaissance mapping, when it may be useful to know the age of a few widely scattered and briefly visited outcrops, or detailed studies of thick sequences with monotonous lithologies.

Conodonts are widespread in marine Middle Cambrian through Triassic rocks. They are not readily recognized in the field, but may be seen using a 10x hand lens.

Conodonts are recoverable from any marine sedimentary rock that can be disintegrated without destroying the fossils. Most conodonts are recovered from limestones, dolostones and, to a lesser extent, shales.

Many of the conodont taxa herein have not yet been taxonomically described or established. Thus, many of the names are informal or are referred to as form species, designated by s.f. (*sensu formo*).

This guide illustrates the current knowledge of the occurrences of conodonts from the upper St. George Group and the Table Head Formation of western Newfoundland. Additional, more detailed information is given by Barnes and Tuke (1970), Fähræus and Nowlan (1978), and Stouge (1980a,b; 1982).

ENVIRONMENTAL CONTROL OF THE CONODONT
FAUNAS

In general, conodonts were dependent on their environment, and, therefore, are restricted to specific lithologies. It has been found that conodont faunas change as environment and lithologies change. In the Ordovician carbonate bank of western Newfoundland, each transgressive-regressive cycle is characterized by its own distinct faunal succession (Stouge, 1980a, 1982).

CONODONT FAUNAS OF THE ST. GEORGE GROUP
AND THE TABLE HEAD FORMATION

Six faunas have been recognized in the St. George Group (Stouge, 1982). They are numbered 1 to 6 in ascending order. The lower two faunas are dominated by simple forms, and the other four faunas are characterized by a large variety of simple and compound conodonts. Plates 1 to 4 and part of Plate 5 show conodonts of the St. George Group.

The Table Head Formation faunas are divided into two zones and four subzones (Stouge, 1980a). The zones are characterized by species of *Histiodella*. The lower subzone is characterized by an assemblage of hyaline forms and is succeeded by a subzone characterized by hyaline compound species associated with a large variety of simple and compound forms. The upper two subzones display a large diversity of many single forms and platforms. Plates 5, 6 and 7 illustrate the conodont faunas of the Table Head Formation.

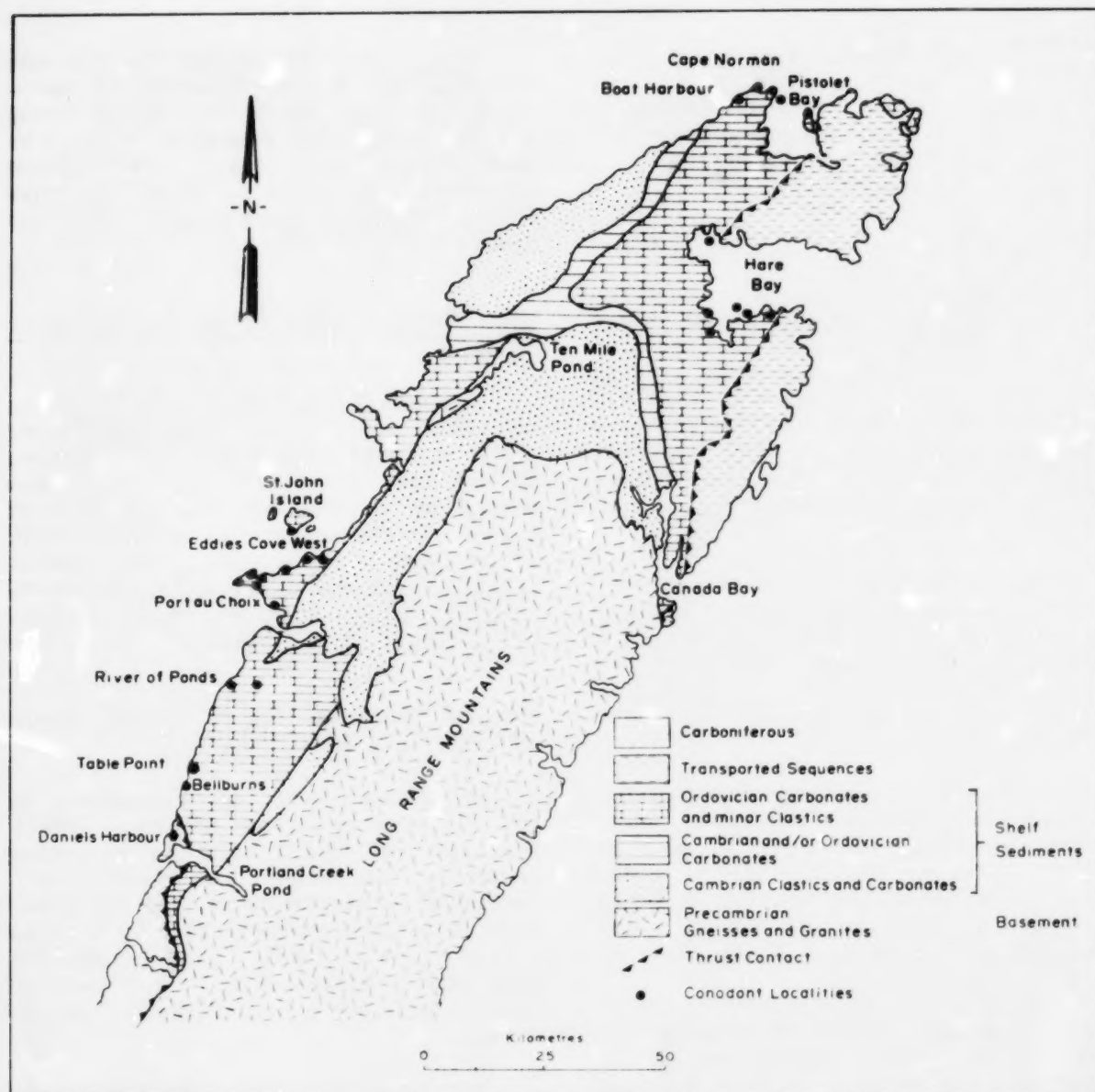


FIGURE 2.1. Geological elements and conodont localities of the Great Northern Peninsula.

Figure 2.1 shows the localities where conodonts illustrated in this publication are found. Figure 2.2 shows the stratigraphic ranges of the most important conodonts collected to date. The ranges are plotted against the lithostratigraphic subdivisions of the St. George Group and the Table Head Formation.

CONODONT SAMPLE COLLECTION PROCEDURE

The method of sampling rock specimens in the field depends on the purpose and the stage of conodont research.

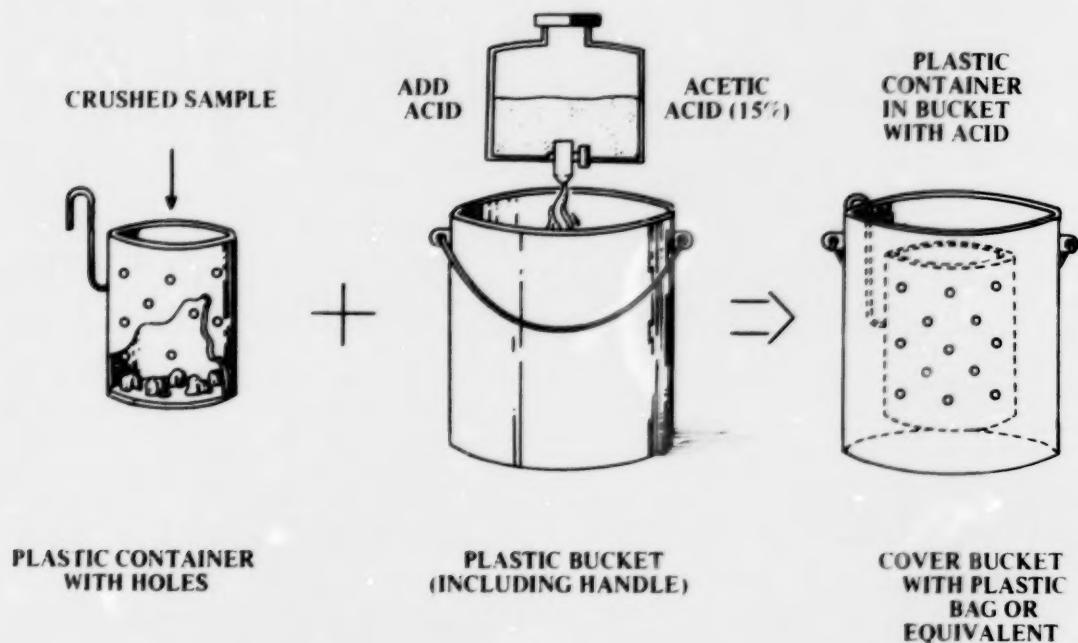
In reconnaissance mapping, the best rock types should be collected. Such rocks include fossiliferous nondolomitized micrites and biosparites in which

TABLE HEAD				Fm.	ST GEORGE GROUP	Upper		Middle	Lower	Fm.	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper</
------------	--	--	--	-----	-----------------------	-------	--	--------	-------	-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	---------

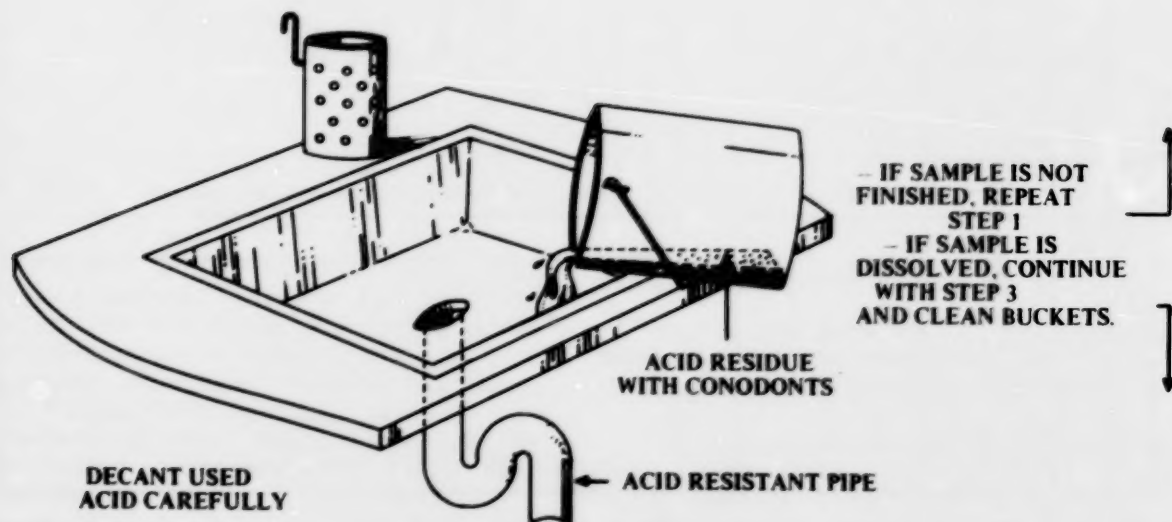
FIGURE 2.2. Ranges of selected Early-Middle Ordovician conodont species on the Great Northern Peninsula. An x marks the single occurrence of a species.

TABLE 2.1. LABORATORY PROCEDURE FOR CONODONT PROCESSING

STEP 1. DISSOLUTION OF SAMPLE BY ACETIC ACID (15%)



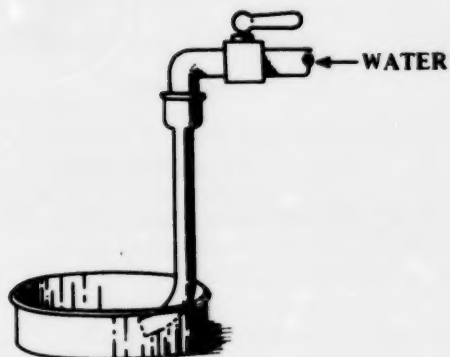
STEP 2. CHANGE OF ACID



STEP 3. CLEANING OF SAMPLE



WASH ACID RESIDUE
THROUGH SIEVES
TOP SIEVE $\sim 1\text{ mm}$
BOTTOM SIEVE 63μ
(OR 74μ)

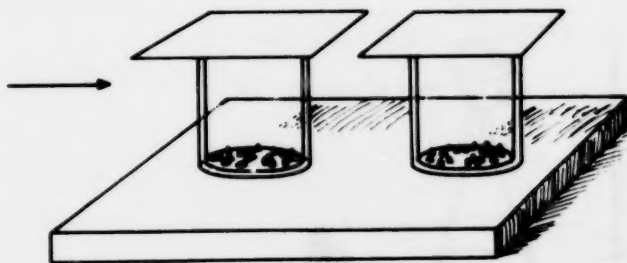


CLEAN SAMPLE CAREFULLY
(2 - 10 minutes)

COLLECT CLEAN RESIDUE
IN LABELLED GLASS
CONTAINER

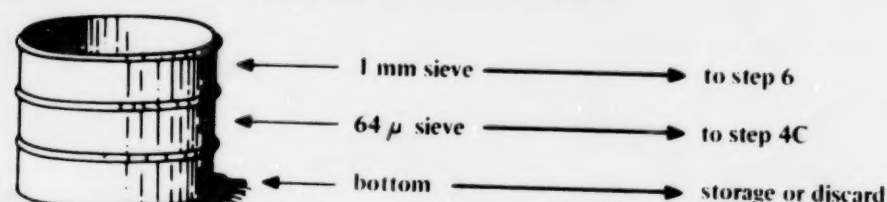


DRY SAMPLE
AT LOW HEAT.
COVER WITH PAPER.



STEP 4. HEAVY SEPARATION

4A. HAND SIEVE DRY SAMPLE



shake sieves

4B. PREPARATION OF HEAVY LIQUID

**MIX TETRABROMOMETHANE
AND BUTANOL (9:1): STIR
TEST HEAVY LIQUID (HL) WITH CALCITE CRYSTAL**



calcite sinks to the bottom:

**LIQUID TOO LIGHT
ADD TETRABROMOMETHANE**

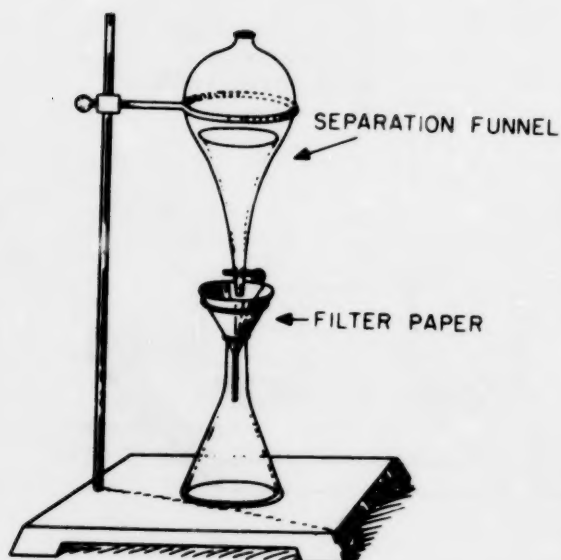
**TETRABROMOMETHANE
+ BUTANOL
(METHYL ALCOHOL)**



calcite floats:

**LIQUID READY FOR
USE. GO TO 4C.**

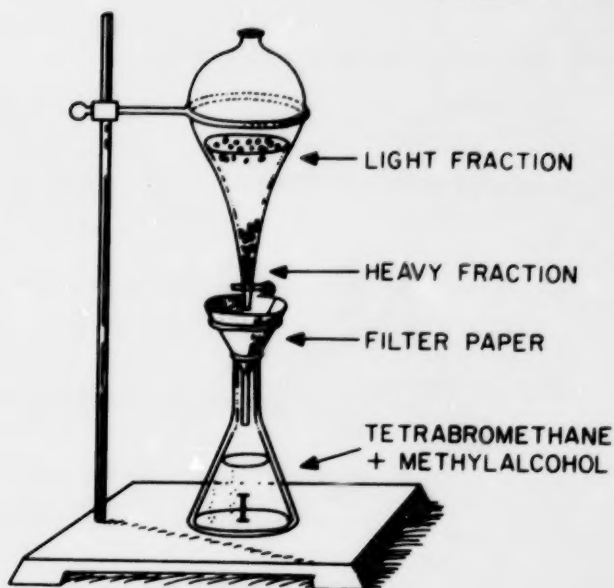
4C. SEPARATION



1. Add heavy liquid from 4B.
2. Add sample from Step 4A.
3. Stir with a glass stick.
4. Wait until separation is completed. Conodonts which are heavier than HL will fall to the bottom of separation funnel.

STEP 4. (CONTINUED)

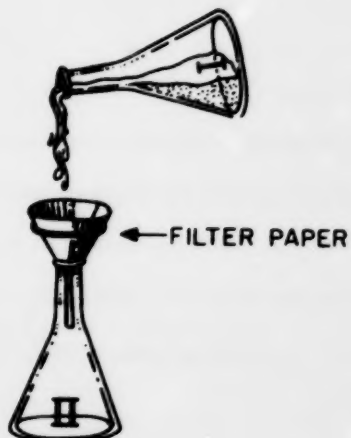
4D. HEAVY RESIDUE



1. Collect heavy fraction in filter paper.
2. Remove funnel with filter paper to separate Erlenmeyer bottle for cleaning. GO TO STEP 5A.
3. Collect light fraction in a new funnel with filter paper. GO TO STEP 4D 2.

4E. CLEANING OF HEAVY LIQUID

TETRABROMETHANE from 4D or 5C.
+ BUTANOL

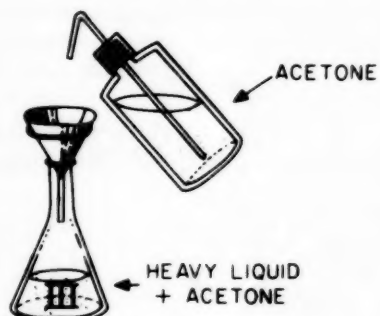


Clean sample through a filter paper.

(empty) Bottle I → STEP 4D

Bottle II → STEP 4B

(empty) Bottle III → STEP 5A

STEP 5. CLEANING OF SAMPLE AND LIGHT FRACTION AND RECOVERY OF HEAVY LIQUID**5A. CLEANING OF SAMPLE WITH ACETONE**

1. Wash sample and filter paper in acetone.
2. Dry clean sample. When dry go to STEP 6.
3. Repeat STEP 5A with the light fraction (5B).
4. Store light fraction (for inspection of other microfossils or lithology) or continue with STEP 6.

5B. CLEANING OF LIGHT FRACTION

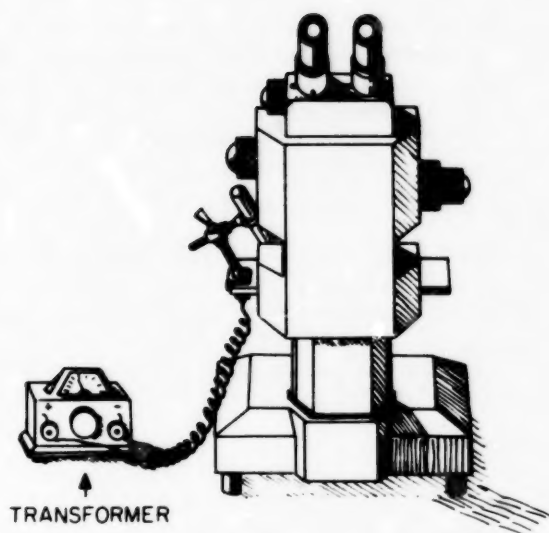
Wash separation funnel clean of residues with acetone through a filter paper. Go to STEP 5C.

5C. RECOVERY OF HEAVY LIQUID

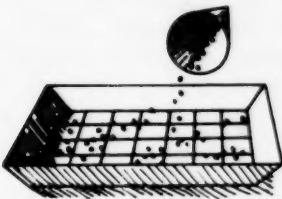
Tetrabromethane is expensive, therefore recycling of the liquid is important.

1. Leave mixture of bottle III (STEP 5A) open to let the acetone evaporate.
2. When the acetone has evaporated go to STEP 4E.

STEP 6. MICROSCOPY



1.  cover the inside of the microslides with traganth (a water soluble glue).

2. 
Distribute the cleaned heavy fraction (STEP 5A 2) on a tray.

3. Search for conodonts using a finely pointed brush.

4. Collect the conodonts on a labelled microslide. Wet the brush when picking.

5. Sort the conodonts.
Identify the fauna (Plates 1-7).
Determine the relative age (Figure 2.2.).

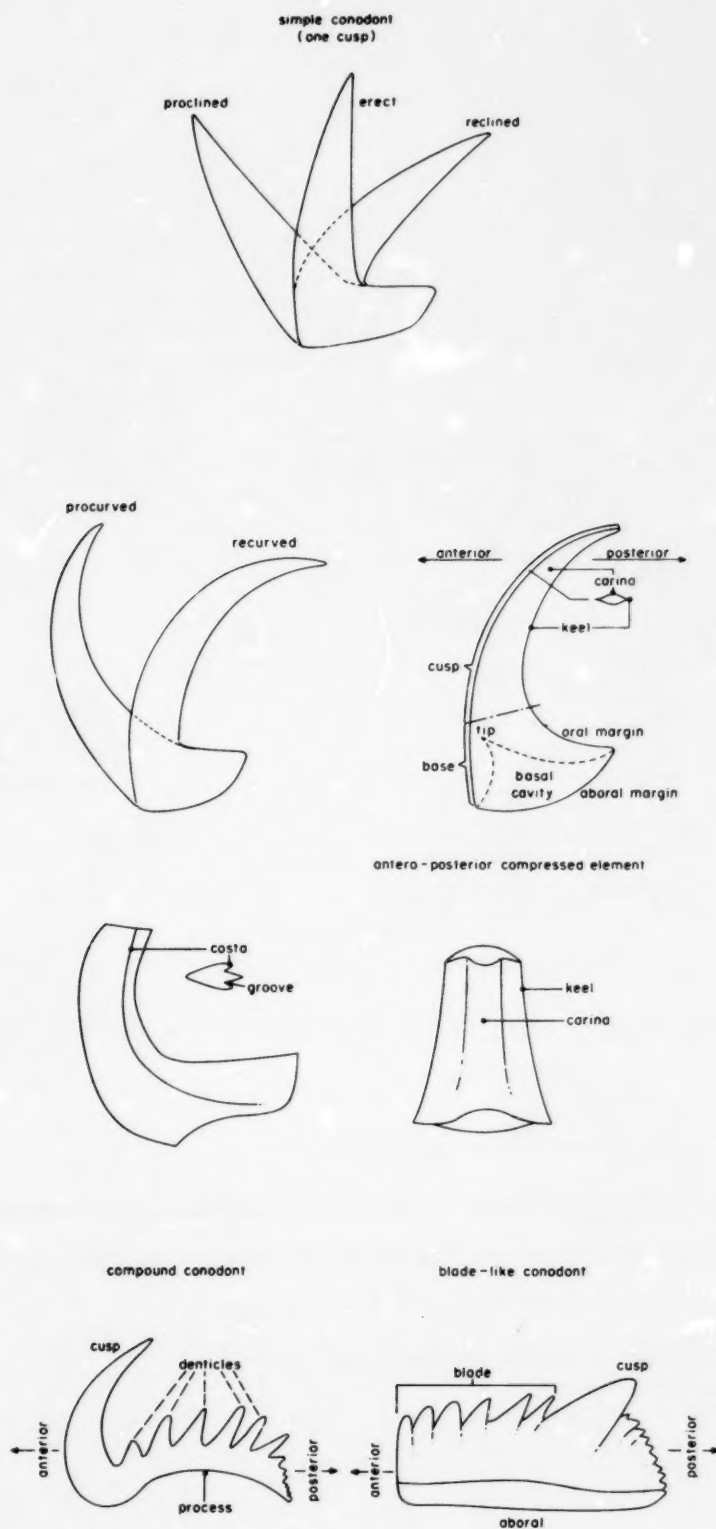


FIGURE 2.3. Conodont morphologic nomenclature.

conodonts are known to be especially abundant. However, where no fossils are seen, larger samples should be collected; these should weigh up to 5-10 kg because conodonts are likely to be scarce.

In detailed studies of thick sequences with monotonous and/or variegated lithologies, one can sample in intervals of metres. However, samples which are representative of each rock type should also be collected.

It is recommended that samples be broken into small pieces and kept in heavy-duty bags (plastic or cloth). The small fragment size is recommended for the later processing in acetic acid. A label should be placed both inside and outside the sample bag.

Drill cores may be split, one half being sent to the laboratory for investigation for conodonts and the other kept for further reference. Petrographical studies may be done on the split core before it is processed for conodonts.

SIMPLE CONODONT PROCESSING PROCEDURE

The general laboratory process for the recovery of conodonts is outlined below and in Table 2.1. The process is based on limestone and dolomitic limestone lithologies only, as most conodonts have been recovered from these lithologies.

PRECAUTIONS

Protection is important for everybody who works with chemicals. Acetic acid is dangerous for the skin, and fumes are very unpleasant. Acetone and the heavy liquid tetrabromethane are highly toxic and should be handled with extreme care (Hauff and Airey, 1980). Safeguards against mishap include well-aerated rooms and/or fumehoods, protective laboratory clothes and rubber gloves. Unless acid can be cleaned up immediately if spilled, fumes may become

concentrated and the room may need to be vacated for several hours. Accidents involving very strong acetic acid and tetrabromethane, particularly in cuts or in eyes, require medical advice and personnel.

IDENTIFICATION

An initial approach for identifying genera and species from the plates is to recognize the overall shape and color of the unit. For example, is it a single cone or a compound element? The next step is to recognize morphological details, and then determine the genus and species from the plates.

The explanation of the plates includes the diagnosis suitable for identification, the first appearance in the stratigraphic record of the elements, and the stratigraphic details. The morphologic nomenclature of conodonts is shown in Figure 2.3.

Hyaline refers to elements which are translucent and amber colored, in contrast to elements containing white matter which have a whitish color and are not translucent.

REFERENCES

- Barnes, C.R. and Tuke, M.F.
1970: Conodonts from the St. George Formation (Ordovician), northern Newfoundland. Geological Survey of Canada Bulletin 187, pages 79-87.
- Epstein, Anita, G., Epstein, F.B., and Harris, L.
1977: Conodont color alteration - an index to organic metamorphism. United States Geological Survey Professional Paper 995, pages 1-27. Washington, D.C.
- Fåhræus, L.E.
1970: Conodont-based correlations of Lower and Middle Ordovician strata in western Newfoundland. Geological Society of America Bulletin, volume 81, pages 2061-2076.

Fähraeus, L.E. and Nowlan, G.S.

1978: Franconian (Late Cambrian) to early Champlainian (Middle Ordovician) conodonts from the Cow Head Group, western Newfoundland. *Journal of Paleontology*, volume 52, number 2, pages 444-471.

Hauff, Phoebe L. and Airey, F.

1980: The handling, hazards and maintenance of heavy liquids in the geologic laboratory. United States Geological Survey Circular 827, 24 pages.

Stouge, S.

1980a: Conodonts of the Table Head Formation (Middle Ordovician); western Newfoundland. Unpublished Ph.D. thesis, Memorial University, St. John's, 413 pages.

1980b: Lower and Middle Ordovician conodonts from central Newfoundland and their correlatives in western Newfoundland. In *Current Research. Edited by C.F. O'Driscoll and R.V. Gibbons*. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-1, pages 134-142.

1982: Preliminary conodont biostratigraphy and correlation of Lower to Middle Ordovician carbonates of the St. George Group, Great Northern Peninsula, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-3, 59 pages.

CHAPTER 3

CAMBRIAN-ORDOVICIAN TRILOBITES OF
SOUTHEASTERN LABRADOR AND THE
GREAT NORTHERN PENINSULAINTRODUCTION

Trilobites are an extinct class of marine arthropods which inhabited the earth's oceans from the Early Cambrian to the Late Permian, a time span greater than 300 million years. They are divisible transversely into three lobes: two pleural lobes and a central axial lobe - hence, the name (from Greek: three-lobes). Trilobites are also divisible into three parts longitudinally: the head (cephalon), the body (thorax) and the tail (pygidium) (Figure 3.1).

Trilobites are present in a large variety of rock types, including limestones, siltstones and shales. They occur less commonly in sandstones and cherts. The trilobites described here occur mainly in shales, calcarenite beds or lenses, and in, on, or between stromatolite mounds. They are often associated with other macrofossils.

Trilobites are the most abundant macrofossils in Cambrian rocks, where they are commonly associated with inarticulate brachiopods. This is fortunate, because the brachiopods are generally more conspicuous and often lead the searcher to the less obvious trilobites.

In Ordovician rocks, trilobites are commonly associated with gastropods, cephalopods and articulate brachiopods. However, if a bed has an extremely large number of gastropods compared to cephalopods and articulate brachiopods, trilobites are generally not found.

Many of the trilobite taxa herein have not been formally described or established taxonomically. Thus, many species are known as sp., spp. or sp. nov., meaning species (singular),

species (plural) and new species, respectively. Generic names enclosed by quotation marks are meant to be informal and the abbreviation "cf." is used in the sense of meaning "similar to", but not identical to.

By no means have all the Cambrian-Ordovician trilobites from western Newfoundland and southeastern Labrador been listed or illustrated. Rather, only the most common, distinctive and/or biostratigraphically useful species are dealt with. Additional, more detailed information has been published by Billings (1865), Boyce (1978, 1979, 1983), Fortey (1979), Fortey and Skevington (1980), Fortey *et al.* (1982), Howell (1943), Howell and Mason (1938), Kindle (1942, 1943, 1948, 1981, 1982), Kindle and Whittington (1958, 1959, 1965), Lochman (1938), Rasetti (1954), Raymond (1913, 1925), Resser (1937), Resser and Howell (1938), Schuchert and Dunbar (1934), Troelsen (1947), Walcott (1910, 1916), Whittington (1953, 1961, 1963, 1965, 1968) and Whittington and Kindle (1963, 1969).

ENVIRONMENTAL CONTROL OF THE TRILOBITE
FAUNAS

In general, most trilobites lived in specific environments and, therefore, now occur in specific lithologies. Like the conodonts in Chapter 2, it has been found that each Cambrian-Ordovician transgressive-regressive cycle is characterized by its own distinct trilobite faunal succession.

TRILOBITE FAUNAS OF THE PLATFORMAL
SEQUENCE

Cambrian trilobite faunas in western Newfoundland are recorded from the Forteau and Hawke Bay Formations (Early Cambrian), the March Point Formation (Middle Cambrian), and the upper dolostone member of the Petit Jardin Formation (Late Cambrian) (Figure 3.2).

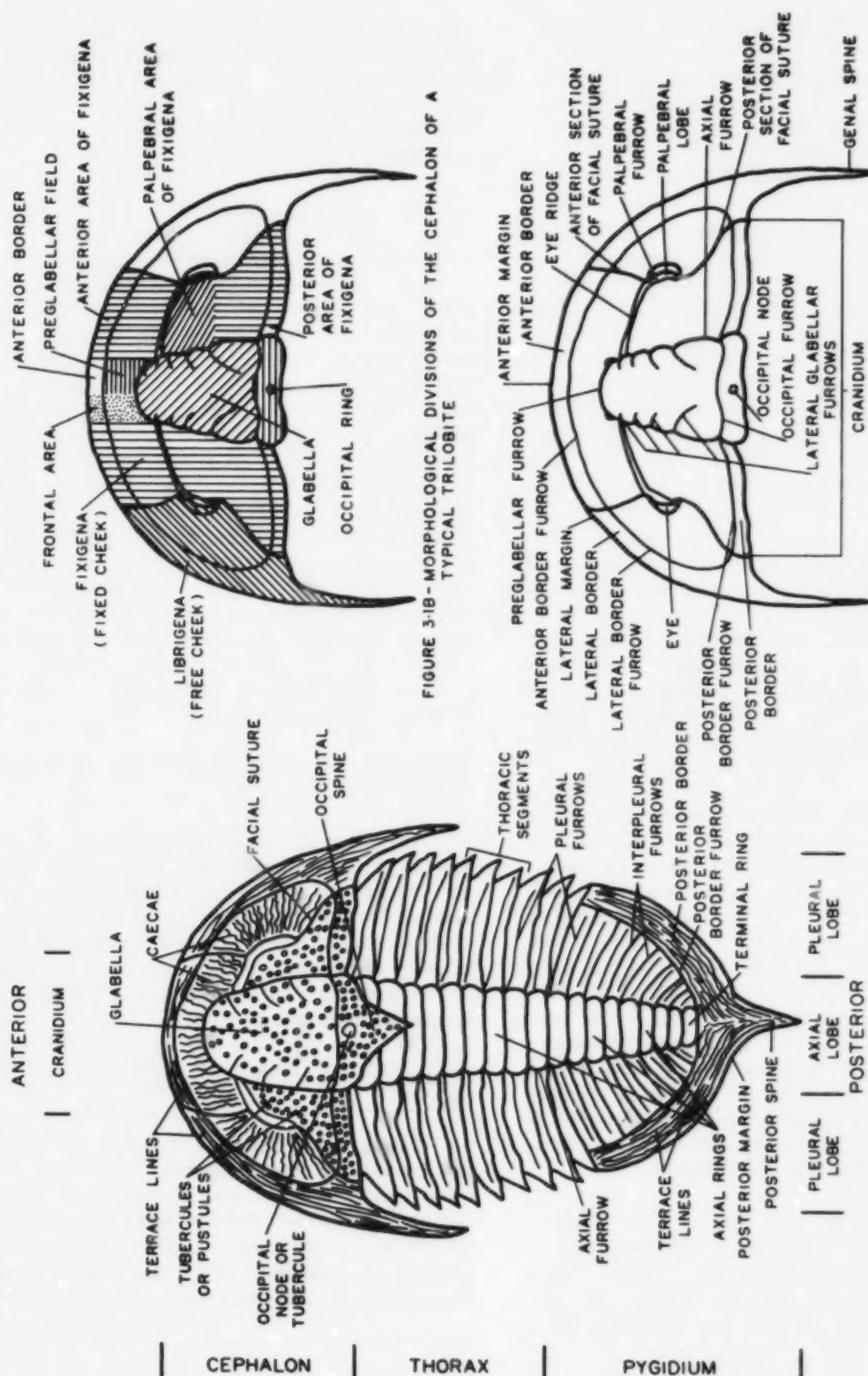


FIGURE 3-1A - GENERAL TRILOBITE MORPHOLOGY

FIGURE 3-1B - MORPHOLOGICAL DIVISIONS OF THE CEPHALON OF A TYPICAL TRILOBITE

FIGURE 3-1C - CEPHALIC NOMENCLATURE OF A TYPICAL TRILOBITE

FIGURES 3-1A, B, C MODIFIED FROM FIGURES 28, 30, 31, RESPECTIVELY, OF MOORE (1959)

FIGURE 3.1. Trilobite morphologic nomenclature.

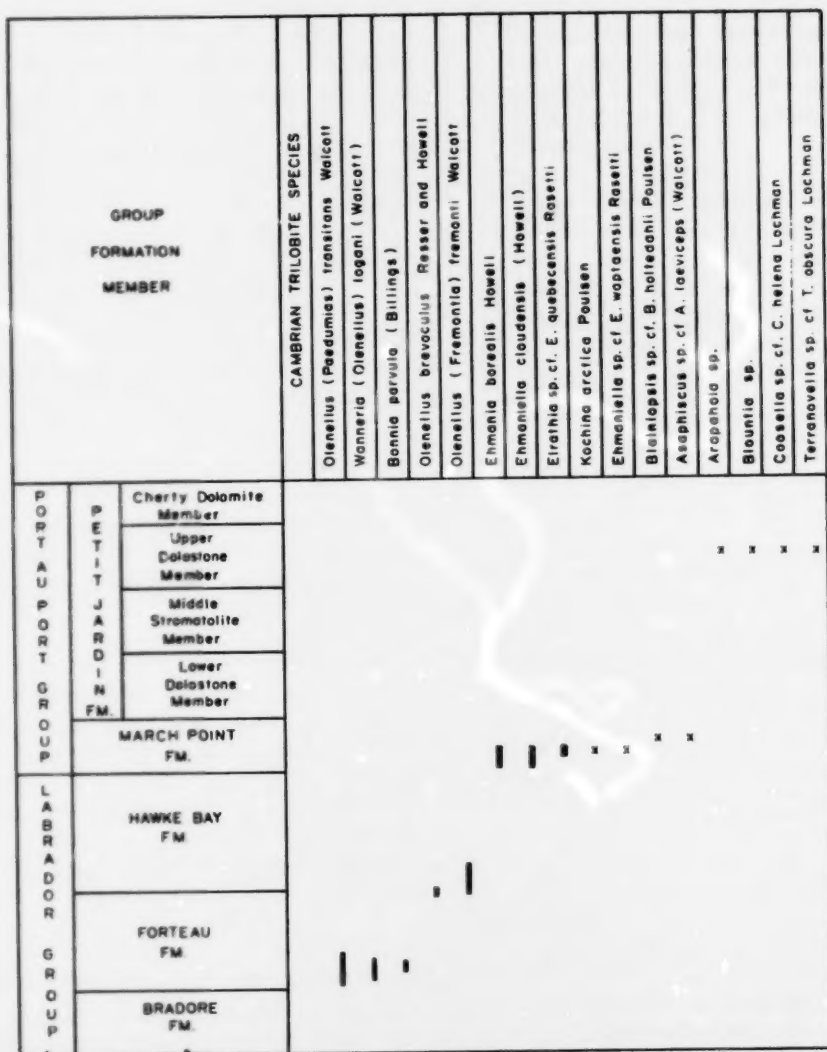


FIGURE 3.2. Ranges of selected Cambrian trilobite species from southeastern Labrador and the Great Northern Peninsula. An x marks the single occurrence of a species.

Trilobites have not been recorded from the Watts Bight Formation; however, ellesmeroceratid cephalopods and conodonts indicate an Early Ordovician (Gasconadian - early Canadian) age.

Middle Canadian hystricurid trilobites occur in the Boat Harbour formation below the 'pebble bed'. Above the 'pebble bed', late Canadian bathyurid trilobites occur in the Boat Harbour and

Catoche Formations. Distinct species distributions allow a division into at least three faunas (Figure 3.3).

TRILOBITE COLLECTION PROCEDURE

When looking for trilobites, it is important to remember that complete specimens are rarely found. While complete specimens are better for strict

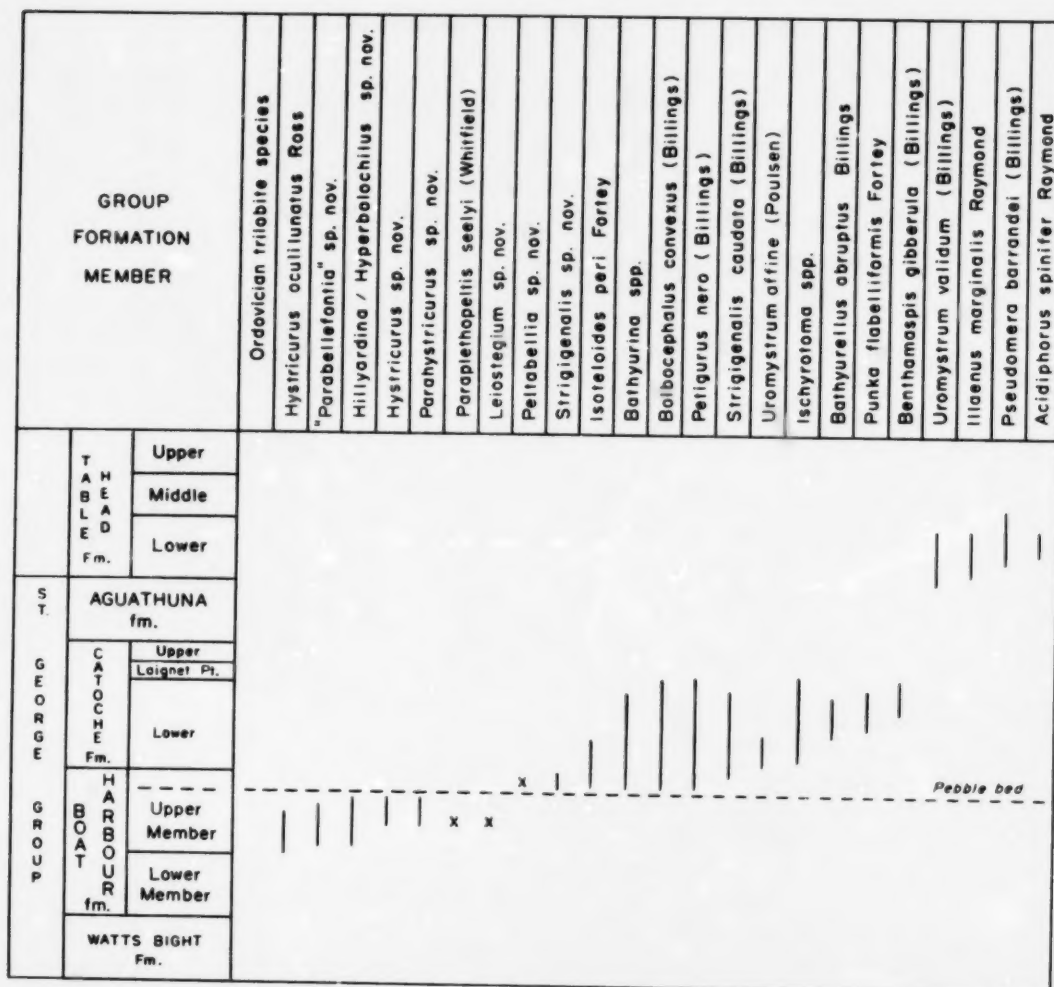


FIGURE 3.3. Ranges of selected Early-Middle Ordovician trilobite species from the Great Northern Peninsula. An x marks the single occurrence of a species. The Table Head species are illustrated in Whittington (1961, 1965).

paleontological description, a moderately preserved cephalon or pygidium is generally sufficient for field identification.

Many of the trilobites found in western Newfoundland are quite small and easily overlooked. It is wise, therefore, to have a good hand lens (preferably X16) with a wide field of view for checking favorable rock types. Trilobites are often easier to spot in talus or float where they are emphasized by differential weathering.

Good eye protection is essential. The limestones and dolostones of western Newfoundland are particularly prone to splintering. A good geological hammer with either a chisel or a point made of well tempered, shatter-free metal is essential. A stone chisel and small sledge hammer are also useful. Broken fossil specimens can be repaired in the field with waterproof plastic model cement. After collection, all specimens should be securely wrapped in tissue or newspaper to prevent abrasion during transport and then placed in a bag well

labelled for the location of the collection. Modelling clay, liquid latex, or plaster can be introduced to a fossil mold or imprint that is not retrievable from outcrop to obtain a retrievable natural replica of the original fossil. Fossils which prove impossible to collect can be photographed or carefully sketched.

IDENTIFICATION

An initial approach in identification of genera and species from the plates is to recognize the overall shape. The next step is to compare the specimen with those in the plates, comparing finer morphological details, for example, whether the trilobite has smooth, punctate, pustular, tuberculate, or terrace-lined surface ornamentation.

The explanation of the plates includes the diagnostic features of each trilobite and a note on its stratigraphic and geographic occurrence.

The common morphological nomenclature of trilobites is shown in Figure 3.1. For additional morphological terms, consult Moore (1959).

REFERENCES

- Billings, E.
1865: Palaeozoic fossils. Volume 1. Containing descriptions and figures of new or little known species of organic remains from the Silurian rocks. 1861-1865. Geological Survey of Canada, 426 pages.
- Boyce, W.D.
1978: Recent developments in western Newfoundland Cambro-Ordovician trilobite biostratigraphy. In Report of Activities for 1977. Edited by R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-1, pages 80-84.
- 1979: Further developments in western Newfoundland Cambro-Ordovician biostratigraphy. In Report of Activities for 1978. *Ibid.*, Report 79-1, pages 7-10.
- 1983: Preliminary Ordovician Trilobite Biostratigraphy of the Eddies Cove West - Port au Choix Area, Western Newfoundland. In Current Research. Edited by M.J. Murray, P.D. Saunders, W.D. Boyce and R.V. Gibbons. *Ibid.*, Report 83-1, pages 11-15.
- Fortey, R.A.
1979: Early Ordovician trilobites from the Catoche Formation (St. George Group), western Newfoundland. Geological Survey of Canada Bulletin 321, pages 61-114.
- Fortey, R.A., and Skevington, D.
1980: Correlation of Cambrian-Ordovician boundary between Europe and North America: new data from western Newfoundland. Canadian Journal of Earth Sciences, volume 17, pages 382-388.
- Fortey, R.A., Landing, E. and Skevington, D.
1982: Cambrian-Ordovician boundary sections in the Cow Head Group, western Newfoundland. In The Cambrian-Ordovician boundary: sections, fossil distributions, and correlations. Edited by M.G. Bassett and W.T. Dean. National Museum of Wales, Geological Series No. 3, Cardiff, pages 95-129.
- Howell, B.F.
1943: Faunas of the Cambrian Cloud Rapids and Treytown Pond Formations of northern Newfoundland. Journal of Paleontology, volume 17, pages 236-297.
- Howell, B.F. and Mason, J.F.
1938: Correlation of Middle Cambrian Faunas of North America. Journal of Paleontology, volume 12, pages 295-297.

- Kindle, C.H.
1942: *Alsataspis* in Newfoundland. Canadian Field Naturalist, volume 56, number 3, page 33.
1943: A preliminary List of Late Cambrian Trilobites Found on the West Coast of Newfoundland. *Ibid.*, volume 57, number 1, pages 7-8.
1948: Crepicephalid Trilobites from Murphy Creek, Quebec and Cow Head, Newfoundland. American Journal of Science, volume 246, pages 441-451.
1981: Cambrian faunas in the limestone conglomerates of western Newfoundland. In Short Papers for the Second International Symposium on the Cambrian System, 1981. United States Geological Survey Open-file Report 81-743, pages 106-110.
1982: The C.H. Kindle Collection: Middle Cambrian to Lower Ordovician Trilobites from the Cow Head Group, Western Newfoundland. In Current Research, Part C. Geological Survey of Canada Paper 82-1C, pages 1-17.
- Kindle, C.H. and Whittington, H.B.
1958: Stratigraphy of the Cow Head region, western Newfoundland. Geological Society of America Bulletin, volume 60, pages 315-342.
1959: Some stratigraphic problems of the Cow Head area in Newfoundland. Transactions of the New York Academy of Sciences, series II, volume 22, pages 7-18.
1965: New Cambrian and Ordovician fossil localities in western Newfoundland. Geological Society of America Bulletin, volume 76, pages 683-688.
- Lochman, C.
1938: Middle and Upper Cambrian faunas from western Newfoundland. Journal of Paleontology, volume 12, pages 461-477.
- Moore, R.C.
1959: Treatise on invertebrate paleontology, Part O, Arthropoda I. Geological Society of America and University of Kansas Press, Lawrence, Kansas, 560 pages.
- Rasetti, F.
1954: Early Ordovician Trilobite Faunules from Quebec and Newfoundland. Journal of Paleontology, volume 28, pages 581-587.
- Raymond, P.E.
1913: Revision of the species which have been referred to the genus *Bathyrurus*. Bulletin of the Victoria Memorial Museum, volume 1, pages 51-69.
1925: Some trilobites of the Lower Middle Ordovician of eastern North America. Harvard University Museum of Comparative Zoology Bulletin, volume 67, number 1, 181 pages.
- Resser, C.E.
1937: Elkanah Billings' Lower Cambrian trilobites and associated species. Journal of Paleontology, volume 11, pages 43-54.
- Resser, C.E. and Howell, B.F.
1938: Lower Cambrian *Olenellus* Zone of the Appalachians. Geological Society of America Bulletin, volume 49, pages 195-248.
- Schuchert, C. and Dunbar, C.O.
1934: Stratigraphy of western Newfoundland. Geological Society of America Memoir 1, 123 pages.
- Troelsen, J.C.
1947: A new Cambrian fauna from western Newfoundland. American Journal of Science, volume 245, pages 537-544.
- Walcott, C.D.
1910: Cambrian Geology and Paleontology I, No. 6. *Olenellus* and other

genera of the Mesonacidae. Smithsonian Miscellaneous Collections, volume 53, number 6, pages, 231-422.

1916: Cambrian Geology and Paleontology III, No. 5. Cambrian Trilobites. *Ibid.*, volume 64, number 5, pages 301-456.

Whittington, H.B.

1953: North American Bathyruridae and Leiostegiidae (Trilobita). Journal of Paleontology, volume 27, pages 647-678.

1961: Middle Ordovician Pliomeridae (Trilobita) from Nevada, New York, Quebec, Newfoundland. *Ibid.*, volume 35, pages 911-922.

1963: Middle Ordovician trilobites from Lower Head, western Newfoundland. Harvard University Museum of Comparative Zoology Bulletin, volume 129, pages 1-118.

1965: Trilobites of the Ordovician Table Head Formation, western Newfoundland. *Ibid.*, volume 132, pages 277-441.

1968: Zonation and correlation of Canadian and early Mohawkian Series. In Studies of Appalachian geology, northern and maritime. Edited by E-an Zen, W.S. White, J.B. Hadley and J.B. Thompson, Jr.. Wiley-Interscience, New York, pages 49-60.

Whittington, H.B. and Kindle, C.H.

1963: Middle Ordovician Table Head Formation, western Newfoundland. Geological Society of America Bulletin, volume 74, pages 745-758.

1969: Cambrian and Ordovician stratigraphy of western Newfoundland. In North Atlantic - geology and continental drift, a symposium. Edited by M. Kay. American Association of Petroleum Geologists Memoir 12, pages 655-664.

STORAGE LOCATIONS OF ILLUSTRATED SPECIMENS

The specimens illustrated on the following plates are housed in several different institutions. These institutions have their own particular cataloguing system with individual identifying abbreviations. These abbreviations are as follows:

- | | |
|--------|--|
| G.S.C. | - Geological Survey of Canada, Ottawa, Ontario. |
| MUNSS | - Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland. |
| NFM | - Newfoundland Museum, St. John's, Newfoundland. |
| ROM | - Royal Ontario Museum, Toronto, Ontario. |

PLATE 1. CONODONTS FROM THE BOAT HARBOUR AND CATOCHE FORMATIONS

- Figure 1: *?Oneotodus variabilis* Lindström s.f.. Early Ordovician. Magnification: x 55, ROM 41912. Hyaline, simple cone with an erect, subrounded cusp. The base is high, slightly flared and has an open basal cavity. Occurrence: Boat Harbour section, Boat Harbour. Range: Boat Harbour formation below the "pebble bed".
- Figures 2,3: *Macerodus dianae* Fähræus and Nowlan. Early Ordovician. Magnification: Figure 2, x 145, ROM 41916; Figure 3, x 65, ROM 41917. Laterally compressed, simple cones, with a short, erect to proclined, keeled and slightly twisted cusp. The base is larger than the cusp and has a deep basal cavity. Occurrence: Boat Harbour section, Boat Harbour. Range: Boat Harbour formation below the "pebble bed".
- Figures 4,7: *Scandodus* sp. A s.f.. Early Ordovician. Magnification: Figure 4, x 60, ROM 41924; Figure 7, x 55, ROM 41925. Erect to recurved, keeled cusp on a high base. The cusp is twisted. Occurrence: Boat Harbour section, Boat Harbour. Range: Boat Harbour formation below the "pebble bed".
- Figures 5,6,8: *Scolopodus?* sp. A. Early Ordovician. Magnification: Figure 5, x 70, ROM 41939; Figure 6, x 125, ROM 41938; Figure 8, x 150, ROM 41935. Small elements with an anteriorly keeled and a posteriorly grooved cusp which has two posterior costae. The cusp is proclined. The base is small and nonexcavated. Both symmetrical and asymmetrical elements are present. Occurrence: Boat Harbour section, Boat Harbour. Range: Boat Harbour formation below the "pebble bed".
- Figures 9,10,11: *Scolopodus?* sp. B. Early Ordovician. Magnification: Figure 9, x 110, ROM 41945; Figure 10, x 70, ROM 41944; Figure 11, x 70, ROM 41942. Simple costate cones with a proclined-procurved cusp. The cusp is antero-posteriorly compressed on symmetrical elements. It has a broad posterior medium carina and two to three furrows. The base is short and slightly excavated. Occurrence: Boat Harbour section, Boat Harbour. Range: Boat Harbour formation below the "pebble bed".
- Figure 12: *Scolopodus? gracilis* Ethington and Clark s.f. Early Ordovician. Magnification: x 60, ROM 41947. Simple symmetrical cone with a proclined cusp, an anterior weak keel and a posterior groove which extends the whole length of the unit. The base is slightly excavated. Occurrence: Port au Choix Peninsula. Range: Boat Harbour formation and Catoche Formation.
- Figures 13,14,15: *Drepanoistodus* sp. A. Early Ordovician. Magnification: Figure 13, x 55, ROM 41931; Figure 14, x 60, ROM 41929; Figure 15, x 100, ROM 41928. Simple laterally compressed cones with keeled cusps. The base may be excavated. The cusp varies from strongly reclined (Figure 15) to recurved (Figure 14) to suberect (Figure 13). Occurrence: Boat Harbour section, Boat Harbour. Range: Boat Harbour formation up to the "pebble bed".
- Figure 16,17: *Juanognathus?* sp. A. Early Ordovician. Magnification: Figure 16, x 85, ROM 41920; Figure 17, x 70, ROM 41921. Antero-posteriorly compressed elements with a proclined cusp on a small base. Both symmetrical and asymmetrical elements occur. The cusp has two postero-lateral keels separated by a deep concave groove on symmetrical elements. Occurrence: Boat Harbour section, Boat Harbour. Range: Boat Harbour formation below the "pebble bed".

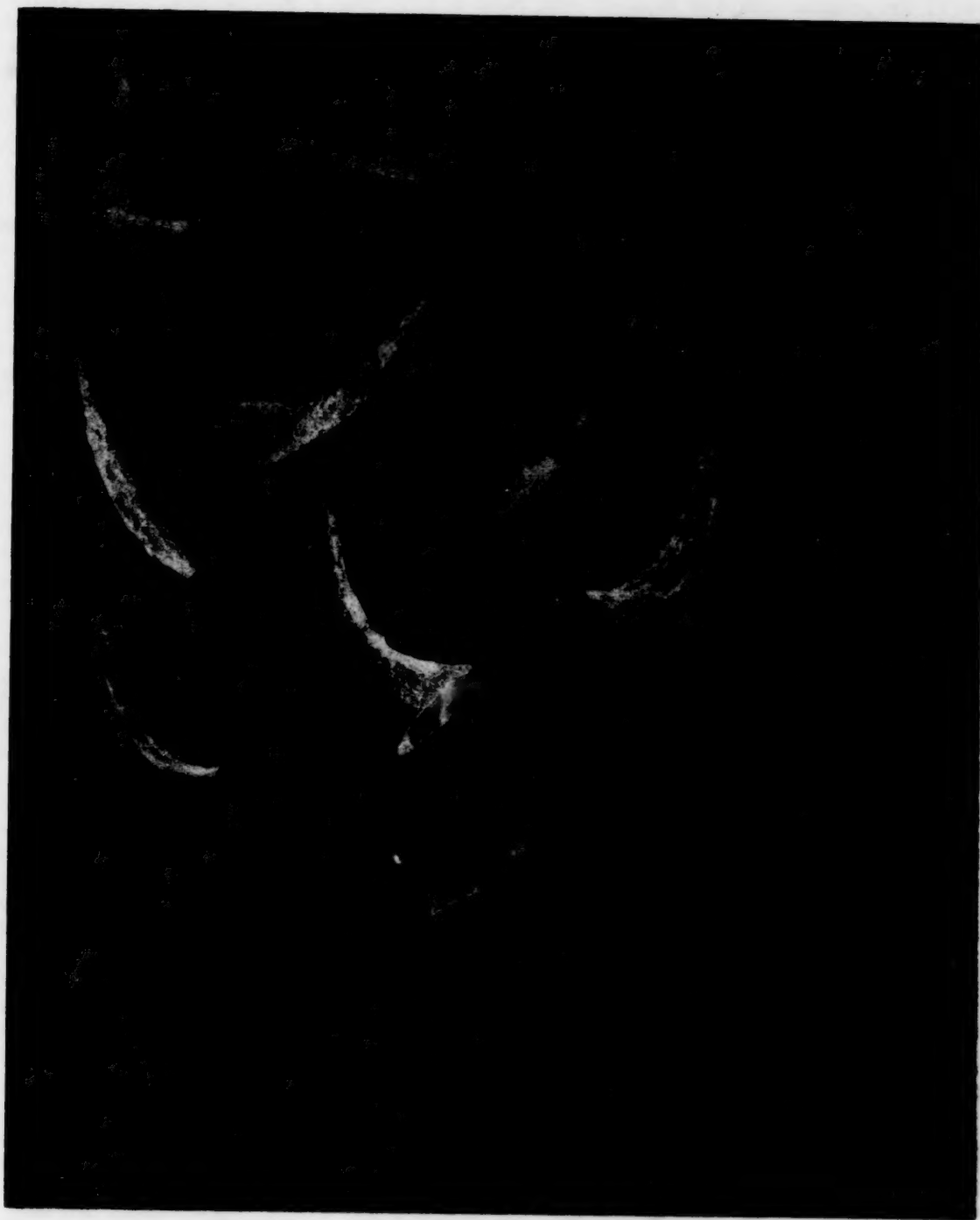


PLATE 2. CONODONTS FROM THE BOAT HARBOUR AND LOWER CATOCHE FORMATIONS

Figure 1: *Drepanodus simplex* Branson and Mehl s.f.. Early Ordovician. Magnification: x 40, ROM 41974. Hyaline, simple cone, with a slightly twisted and keeled cusp. The cusp is reclined to erect, and the terminal fourth is pointed. The base is excavated and expanded. Occurrence: Eddies Cove West. Range: Top of Boat Harbour formation and lower Catoche Formation.

Figure 2: *Oistodus inaequalis* Pander s.f.. Early Ordovician. Magnification: x 40, ROM 41996. Simple cone with a large reclined and keeled cusp. The cusp has an inner broad carina. The base is triangular in lateral view and flared on the inner side. Occurrence: Port au Choix Peninsula. Range: Top of Boat Harbour formation and Catoche Formation.

Figures 3,4,5: '*Scolopodus*' *quadruplicatus* Branson and Mehl s.f.. Early Ordovician. Magnification: Figure 3, x 75, ROM 41963; Figure 4, x 40, ROM 41964; Figure 5, x 75, ROM 41965. Symmetrical to asymmetrical, multicostate and hyaline simple cones. The cusp varies from reclined to proclined. The base is excavated. Occurrence: Port au Choix Peninsula. Range: Top of Boat Harbour formation and lower Catoche Formation.

Figures 6,7: *Drepanodus? gracilis* (Branson and Mehl). Early Ordovician. Magnification: Figure 6, x 55, ROM 41961. Figure 7, x 75, ROM 41960. Simple cones with laterally compressed and keeled cusps. Cusp varies from strongly reclined (Figure 6) to recurved (Figure 7). The base is rhombohedric in lateral view on reclined specimens. Occurrence: Port au Choix Peninsula. Range: Boat Harbour formation above the "pebble bed", and lower Catoche Formation.

Figures 8,9: *Drepanodus parallelus* Branson and Mehl s.f.. Early Ordovician. Magnification: Figure 8, x 40, ROM 41978; Figure 9, x 30, ROM 41979. Simple hyaline cones with laterally compressed cusps. The cusp is erect to reclined and is gradually tapering towards the tip. The base is small and slightly expanded. Occurrence: Port au Choix Peninsula. Range: Top of Boat Harbour formation and lower Catoche Formation.

Figures 10 - 16: *Aodus* sp. cf. *A. deltatus* Lindström. Early Ordovician. Magnification: Figure 10, x 115, ROM 41966; Figure 11, x 115, ROM 41967; Figure 12, x 65, ROM 41970; Figure 13, x 60, ROM 41973; Figure 14, x 105, ROM 41968; Figure 15, x 115, ROM 41972; Figure 16, x 120, ROM 41969. Elements with a cusp and two, three and four adenticulate processes. Figures 12 and 13: Elements with one posteriorly extended posterior process. The elements are recurved or strongly reclined. Figures 11 and 15: Symmetrical element with one cusp and three posteriorly directed processes. Figure 10: Asymmetrical element with an anterior, a posterior, and an antero-lateral process. Figures 14 and 16: Element with four processes. Occurrence: East of Cape Norman. Range: Boat Harbour formation above the "pebble bed".

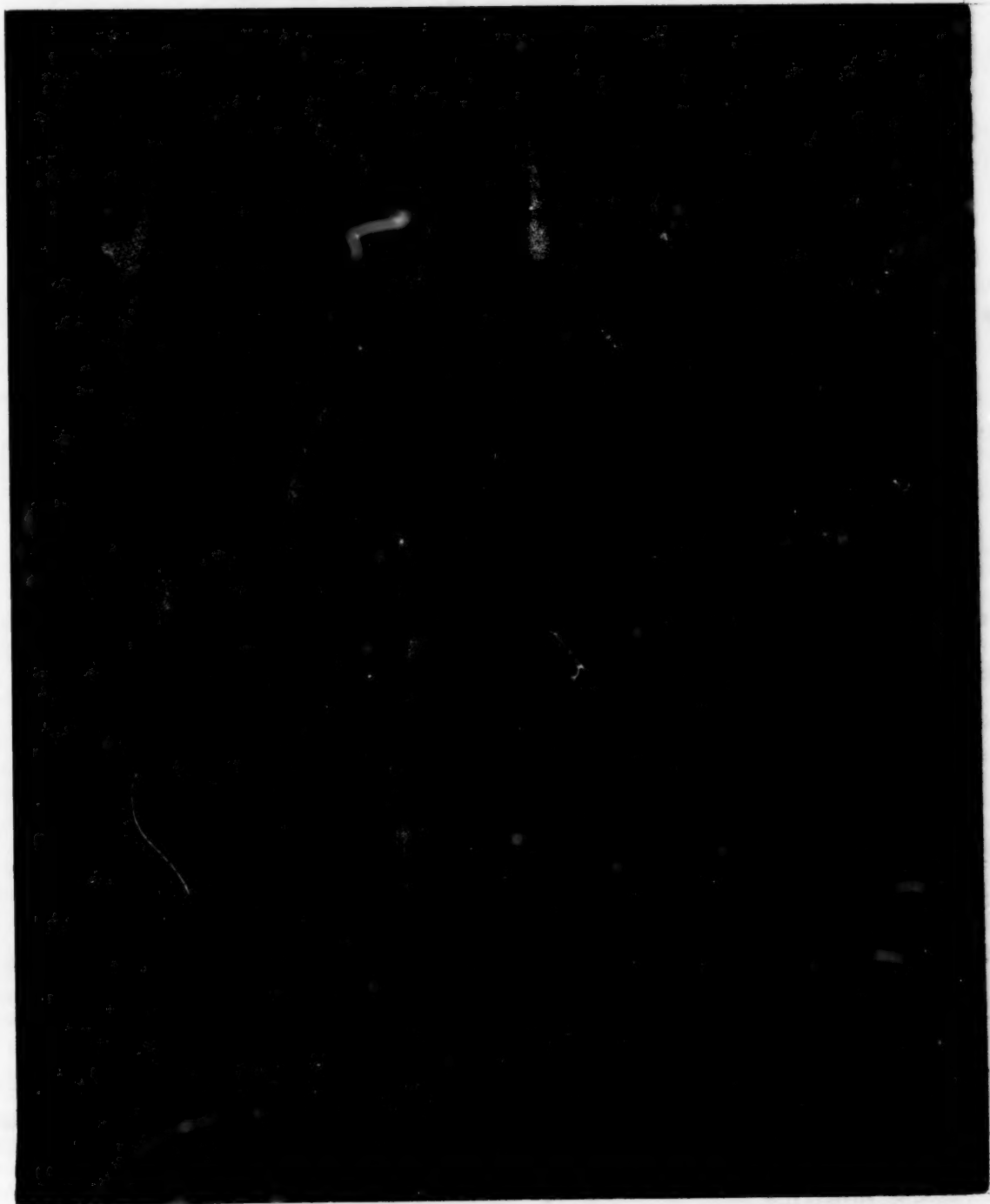


PLATE 3. CONDOTS FROM THE BOAT HARBOUR, CATOCHE, AGUATHUNA AND TABLE HEAD FORMATIONS

Figures 1,2: *Loxodus?* sp. aff. *Loxodus bransoni* Furnish. Early Ordovician. Magnification: Figure 1, x 65, ROM 41994; Figure 2, x 100, ROM 41995. Genus with two elements. One element is strongly reclined (Figure 1) and has a short cusp and a large base. The second has a small erect cusp and up to four progressively reclined denticles (Figure 2). Occurrence: Port au Choix Peninsula. Range: Lower Catoche Formation.

Figure 3: *Scolopodus?* sp. C s.f.. Early Ordovician. Magnification: x 90, ROM 41977. Small blade with slightly excavated basal cavity. The blade has numerous "cone in cone" costae and a posterior median groove. Occurrence: Port au Choix Peninsula. Range: Top of the Boat Harbour formation and the Catoche Formation.

Figures 4 - 6: *Oepikodus communis* (Ethington and Clark). Early Ordovician. Magnification: Figure 4, x 60, ROM 41992; Figure 5, x 125, ROM 41990; Figure 6, x 120, ROM 41991. Elements with a cusp and two, three and four processes. The posterior process has numerous closely spaced denticles. Occurrence: Port au Choix Peninsula. Range: Lower Catoche Formation.

Figure 7: *Oneotodus costatus* Ethington and Brand. Early Ordovician. Magnification: x 60, ROM 41953. Simple costate cone with reclined cusp. The cross-section of the cusp is circular. The base is excavated. Occurrence: Port au Choix Peninsula. Range: Catoche Formation.

Figures 8,9: *Scolopodus?* *gracilis* Ethington and Clark s.f.. Early/Middle Ordovician. Magnification: Figure 8, x 70, ROM 41011; Figure 9, x 75, ROM 41010. Simple cones with a proclined cusp and a posterior median groove. The specimens are hyaline and have visible surface striations. Occurrence: Port au Choix Peninsula. Range: Catoche to Table Head Formation.

Figure 10: *Oistodus delta* Lindström. s.f.. Early Ordovician. Magnification: x 25, ROM 42001. Antero-posterior compressed hyaline element with lateral keels that extend posterior as alate processes. A median/ posterior costa on the cusp continues to the base. Occurrence: Port au Choix Peninsula. Range: Lower Catoche Formation.

Figure 11: *Drepanoistodus* sp. B. Early Ordovician. Magnification: x 30, ROM 41950. Laterally compressed elements with strongly reclined, erect to proclined cusps. Occurrence: Port au Choix Peninsula. Range: Catoche Formation.

Figure 12: *Ulrichodina* sp. A s.f.. Early Ordovician. Magnification: x 75, ROM 41959. Erect simple cone with a rounded anterior edge, an infolded anterior base and a posterior keel on cusp. The base is very small. Occurrence: Eddies Cove West. Range: Top of Boat Harbour formation and Lower Catoche Formation.

Figures 13,14: *Tropodus comptus* (Branson and Mehl). Early Ordovician. Magnification: Figure 13, x 75, ROM 41988; Figure 14, x 55, ROM 41985. Figure 13: Asymmetrical element with three adenticulate processes. Element has auxillary costae. Figure 14: Symmetrical element with four adenticulate processes and intermediate costae. Occurrence: Port au Choix Peninsula. Range: Top of Boat Harbour formation and Catoche Formation.

Figure 15: *Acodus?* sp. cf. *A. delicatus* Branson and Mehl. Early Ordovician. Magnification: x 55, ROM 41982. Element with a large blade-like cusp and an inner flared base. Occurrence: Port au Choix Peninsula. Range: Top of Boat Harbour formation and Catoche Formation.



PLATE 4. CONODONTS FROM THE CATOCHE, AGUATHUNA AND LOWER TABLE HEAD FORMATIONS

- Figures 1,2: *Drepanodus? arcuatus* Pander. Early Ordovician. Magnification: Figure 1, x 80, ROM 41019; Figure 2, x 80, ROM 41018. Simple cones with a recurved cusp and a base with a convex oral keel. Occurrence: Port au Choix Peninsula. Range: Upper Catoche Formation (Laignet Point Member).
- Figures 3,4,7: *Semiacontiodus* sp. cf. *S. asymmetricus* (Barnes and Poplawski). Early/Middle Ordovician. Magnification: Figure 3, x 115, ROM 41014; Figure 4, x 130, ROM 41016; Figure 7, x 60, ROM 42015. Symmetrical (Figures 4 and 7) and asymmetrical (Figure 3) antero-posterior compressed elements with a proclined cusp. One or two posterior grooves are present. The elements are visibly striated. Occurrence: Port au Choix Peninsula. Range: Catoche Formation and lower third of lower Table Head Formation.
- Figures 5,8: *Protoprioniodus* sp. A. Early Ordovician. Magnification: Figure 5, x60, ROM 42005; Figure 8, x 65, ROM 42004. Elements with a reclined cusp, an anteriorly extended base and an arched posterior process. The cusp is keeled and has an inner lateral carina (Figure 8) or an antero-lateral costa that continues beyond the aboral margin as a short adenticulate process (Figure 5). Occurrence: Port au Choix Peninsula. Range: Catoche Formation.
- Figures 6,9: *Protoprioniodus* sp. B. Early Ordovician. Magnification: Figure 6, x 95, ROM 42043; Figure 9, x 70, ROM 42030. The elements are similar to those of Figures 5 and 8, but have denticles on the posterior process. Occurrence: Port au Choix Peninsula. Range: Catoche Formation.
- Figure 10: *Oepikodus* sp. cf. *O. communis* (Ethington and Clark). Early to early Middle Ordovician. Magnification: x 120, ROM 42037. Compound element with a posterior, slightly twisted, denticulate process and an inner lateral adenticulate process. Occurrence: North of Table Point. Range: Upper Catoche and Aguathuna Formations.
- Figure 11: *Semiacontiodus* sp. cf. *S. cordis* (Hamar). Early to early Middle Ordovician. Magnification: x 100, ROM 41012. Simple cone with a twisted cusp, an excavated base, and visible surface striations. Occurrence: Port au Choix Peninsula. Range: Upper Catoche to Table Head Formation.
- Figure 12: *?Microzarkodina marathonensis* (Bradshaw). Early Ordovician. Magnification: unknown, no catalogue number. Compound element with a posterior denticulate process, a cusp and an anterior "anticusp". Denticles become increasingly reclined toward the posterior. Occurrence: Port au Choix Peninsula. Range: Upper Catoche Formation.
- Figures 13,14: *?Paroistodus parallelus* (Pander). Early Ordovician. Magnification: Figure 13, x 70, ROM 42024; Figure 14, x 140, ROM 42026. Species with simple elements which are either strongly reclined with a rectangular base (Figure 13) or recurved with a posteriorly extended base (Figure 14). Occurrence: Port au Choix Peninsula. Range: Catoche Formation (Laignet Point Member).
- Figures 15,16: *Bergstroemognathus extensus* Serpagli. Early Ordovician. Magnification: Figure 15, x 30, ROM 42020; Figure 16, x 55, ROM 42021. Compound denticulate specimens forming a symmetry transition series. Figure 15: Specimen with a long anterior denticulate process, a small cusp and a slightly excavated basal cavity. Figure 16: Asymmetrical element with one denticulate lateral process and one short adenticulate lateral process. The cusp is tall and erect. The unit is laterally bent. Occurrence: Port au Choix Peninsula. Range: Catoche Formation (Laignet Point Member).



PLATE 5. CONODONTS FROM THE AGUATHUNA AND LOWER TABLE HEAD FORMATIONS

Figures 1 - 4,7: *Eoneoproniodus?* sp. A. Middle Ordovician. Magnification: Figure 1, x 50, MUNSS 74; Figure 2, x 50, MUNSS 74; Figure 3, x 50, MUNSS 74; Figure 4, x 45, MUNSS 74; Figure 7, x 50, MUNSS 74. Hyaline compound elements with one, two or three denticulate processes and a large cusp. Occurrence: Table Point. Range: Aguathuna formation and basal part of lower Table Head Formation.

Figures 5,6: *Trigonodus* sp. nov. A. Middle Ordovician. Magnification: Figure 5, x 50, MUNSS 29; Figure 6, x 45, MUNSS 28. Simple keeled and hyaline cones with two to four keels on cusp. Cusp is recurved to procurved. The symmetrical element (Figure 5) is antero-posteriorly compressed. Occurrence: Table Point. Range: Aguathuna formation and lower part of Table Head Formation.

Figure 8: *Leptochirognathus prima* Branson and Mehl. Middle Ordovician. Magnification: Figure 8, x 140, MUNSS 61. Hyaline denticulate bar with an erect cusp and reclined posterior denticles. The base is slightly excavated beneath the denticle next to cusp. Occurrence: Table Point. Range: Aguathuna formation and basal lower Table Head Formation.

Figures 9 - 12: *?Erraticodon balticus* Dzik. Middle Ordovician. Magnification: Figure 9, x 50, MUNSS 79; Figure 10, x 55, MUNSS 79; Figure 11, x 55, MUNSS 79; Figure 12, x 40, MUNSS 79. Hyaline, symmetrical and asymmetrical compound elements with one to three delicately denticulate processes. Commonly, the fourth or fifth denticle on the posterior process is extra large. Occurrence: Table Point. Range: Lower and lower middle Table Head Formation.

Figures 13 - 16: *Scalpellodus* spp. Middle Ordovician. Magnification: Figure 13, x 40, MUNSS 38; Figure 14, x 35, MUNSS 38; Figure 15, x 40, MUNSS 39; Figure 16, x 45, MUNSS 39. Simple cones with a proclined to erect cusp. Elements are twisted and some carry a posteriorly directed anterior adenticulate process. Occurrence: Table Point. Range: Lower Table Head Formation. Specimens illustrated in figures 13 and 14 are from the lower Table Head Formation; those illustrated in figures 15 and 16 are from the upper part of the lower Table Head Formation.

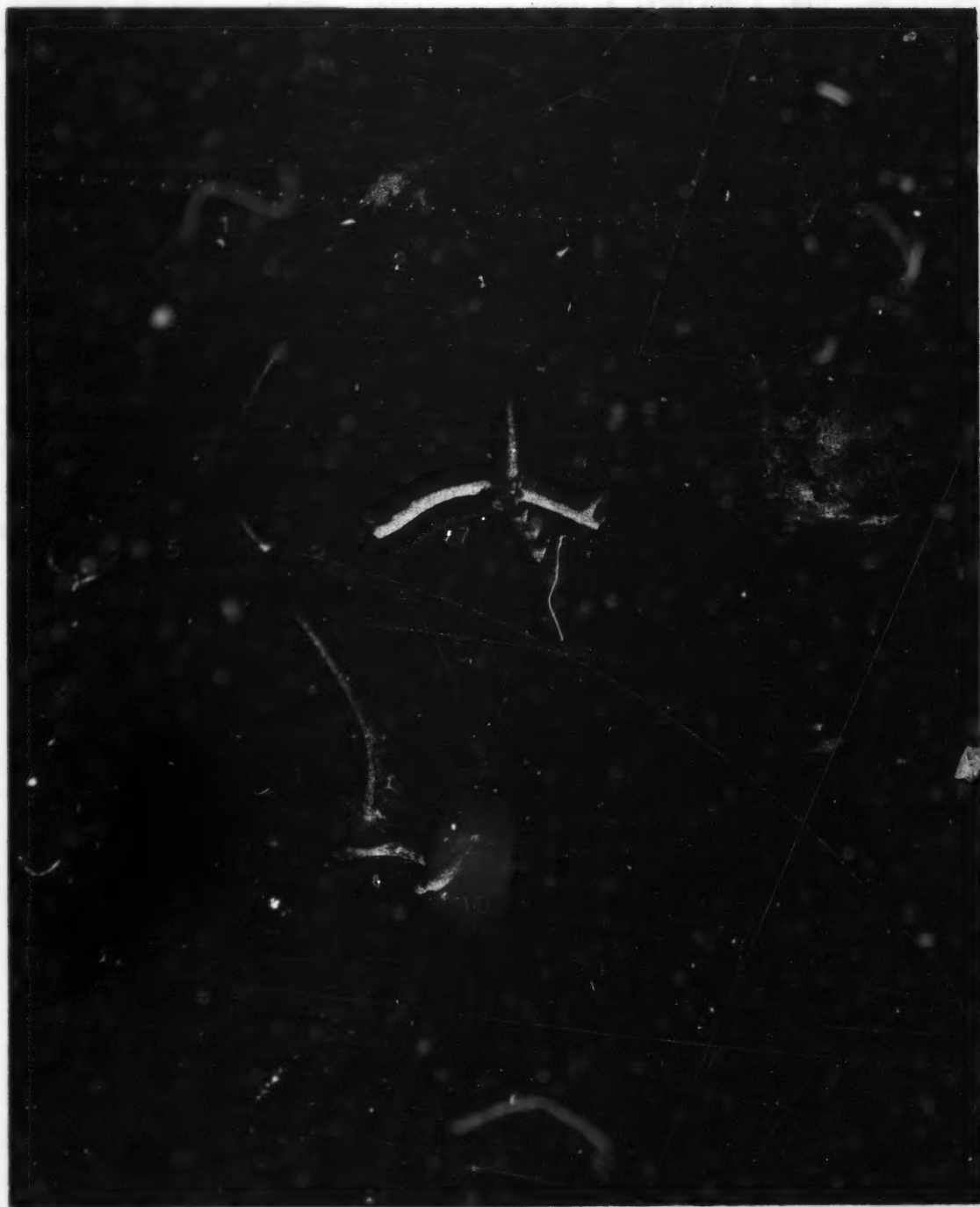


PLATE 6. CONODONTS FROM THE TABLE HEAD FORMATION

Figure 1: Gen. nov. A sp. nov. A. Middle Ordovician. Magnification: x 55, MUNSS 45. Simple cone with a procurved and keeled cusp. The cusp has a posterior median groove between two carinas. Occurrence: Table Point. Range: Lower and lower middle Table Head Formation.

Figures 2-8: *Belodella* spp.. Middle Ordovician. Magnification: Figure 2, x 125, MUNSS 34; Figure 3, x 95, MUNSS 34; Figure 4, x 100, MUNSS 33; Figure 5, x 90, MUNSS 33; Figure 6, x 80, MUNSS 33; Figure 7, x 75, MUNSS 33; Figure 8, x 110, MUNSS 33. Adenticulate (Figures 3, 6, 7) simple elements and denticulate (Figures 2, 4, 5 and 8) compound elements. The adenticulate elements have a proclined (Figures 3 and 7) to reclined (Figure 6) cusp and a large base. The denticulate specimens vary from symmetrical (Figures 2 and 4) to asymmetrical (Figures 5 and 8). Occurrence: Table Point. Range: Lower and middle Table Head Formation.

Figures 9-14: *Periodon aculeatus xgierzensis* Dzik. Middle Ordovician. Magnification: Figure 9, x 60, MUNSS 76; Figure 10, x 90, MUNSS 76; Figure 11, x 85, MUNSS 76; Figure 12, x 65, MUNSS 76; Figure 13, x 80, MUNSS 76; Figure 14, x 70, MUNSS 76. Compound conodonts with a reclined cusp and denticles on the anterior part of the base (Figure 9); elements with an erect cusp and two denticulate processes (Figures 11 and 12); and elements with a long denticulate posterior process (Figures 10, 13, and 14). One denticle is larger than the others on the posterior process on these elements. Occurrence: Table Point. Range: Lower (rare) and middle Table Head Formation (common).

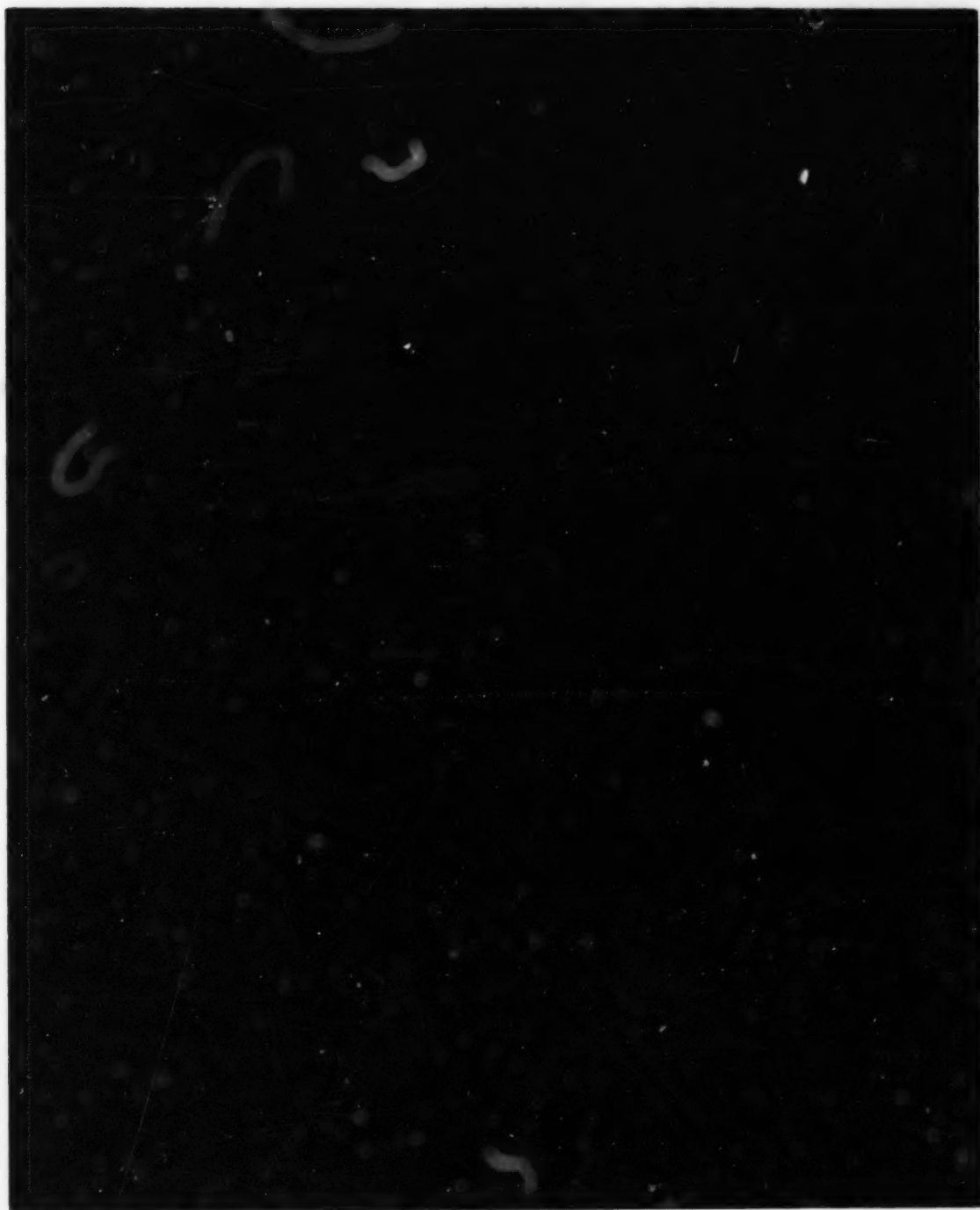


PLATE 7. CONODONTS FROM THE TABLE HEAD FORMATION

Figures 1-3: *Histiodellla* spp.. Middle Ordovician. Magnification: Figure 1, x 65, MUNSS 84; Figure 2, x 120, MUNSS 84; Figure 3, x 100, MUNSS 82. Denticulate blade with a reclined cusp in the posterior third of the blade. Specimens illustrated in figures 1 and 2 are from the lower Table Head Formation; that illustrated in figure 3 is from the middle Table Head Formation. Occurrence: Table Point. Range: Table Head Formation.

Figures 4-6: *Acodus combsi* Bradshaw. Middle Ordovician. Magnification: Figure 4, x 80, MUNSS 71; Figure 5, x 90, MUNSS 71; Figure 6, x 80, MUNSS 71. Adenticulate specimens with a recurved, keeled cusp (Figure 5), with one costate cusp and base (Figure 4) and with two (Figure 6) to four costae on cusp and base. Occurrence: Table Point. Range: Lower (rare) and middle Table Head Formation.

Figures 7-9: *Cordylodus? horridus* Barnes and Poplawski. Middle Ordovician. Magnification: Figure 7, x 65, MUNSS 1; Figure 8, x 65, MUNSS 1; Figure 9, x 95, MUNSS 1. Compound elements with an erect to recurved cusp and one posterior denticulate process. Occurrence: Table Point. Range: Lower (rare) and middle Table Head Formation.

Figures 10,11,14,15: *Oistodus? sp. nov.* A. Middle Ordovician. Magnification: Figure 10, x 55, MUNSS 69; Figure 11, x 50, MUNSS 69; Figure 14, x 35, MUNSS 69; Figure 15, x 65, MUNSS 70. Large and robust hyaline elements with a recurved, keeled cusp. Some specimens have lateral costae (Figure 11). The posterior process is long and arched. Occurrence: Table Point. Range: Lower (rare) and middle Table Head Formation.

Figures 12,13: *Walliserodus ethingtoni* Fähræus. Middle Ordovician. Magnification: Figure 12, x 80, MUNSS 44; Figure 13, x 50, MUNSS 44. Simple cones with a recurved multi-costate cusp. Occurrence: Table Point. Range: Lower (rare) and middle Table Head Formation.

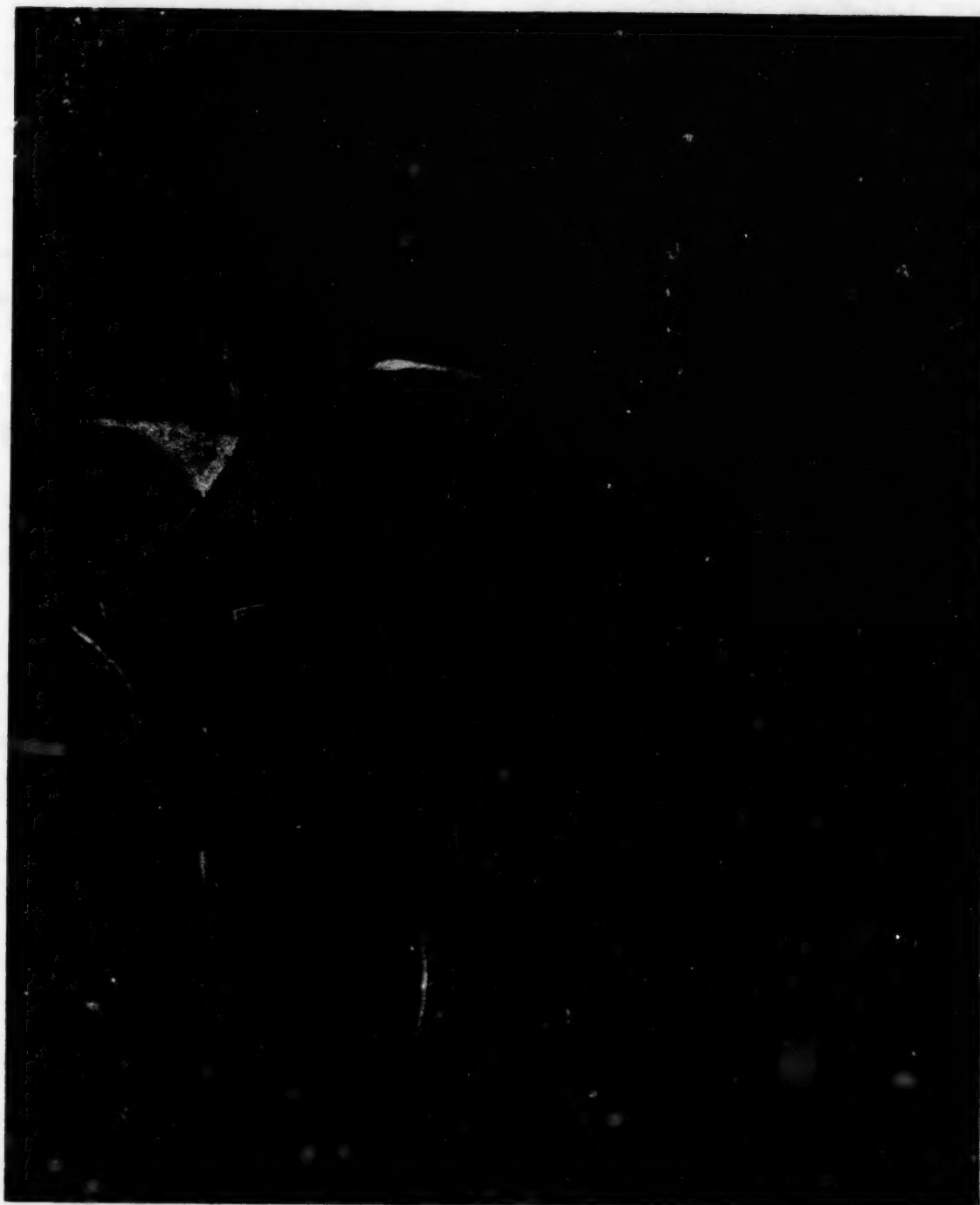
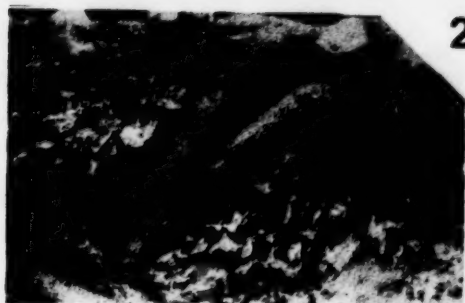


PLATE 8. TRILOBITES FROM THE FORTEAU, HAWKE BAY AND MARCH POINT FORMATIONS

- Figures 1,2: *Wanneria (Olenellus) loqani* (Walcott). Late Early Cambrian. Magnification: Figure 1, x 8, NFM F-54; Figure 2, x 4, NFM F-55. Figure 1: Fragmentary left portion of cephalon displaying reticulate surface ornamentation with terrace lines along lateral cephalic border. Figure 2: Fragmentary left portion of thoracic segment displaying reticulate surface ornamentation. Occurrence: Point Amour, southeastern Labrador. Range: Forteau Formation (Labrador Group).
- Figures 3, 4: *Bonnina parvula* (Billings). Late Early Cambrian. Magnification: Figure 3, x 6, NFM F-56; Figure 4, x 9, NFM F-57. Figure 3: Cranidium displaying strong, circular terrace-lined surface ornamentation on occipital ring and anteriorly expanding glabella. Figure 4: Pygidium semicircular, with weakly developed pleural and interpleural furrows; relatively weakly defined posterior border; and strong, circular terrace-lined surface ornamentation on axial rings. Occurrence: Point Amour, southeastern Labrador. Range: Forteau Formation (Labrador Group).
- Figure 5: *Olenellus (Paedumias) transitans* Walcott. Late Early Cambrian. Magnification: x 3, NFM F-58. Cephalon showing large, semicircular eyes extending back to posterior border furrow. Occurrence: Three Mile Lake Quarry, St. Margaret's Bay. Range: Forteau Formation (Labrador Group).
- Figure 6: *Olenellus (Fremontia) fremonti* Walcott. Late Early Cambrian. Magnification: x 2, NFM F-59. Cephalon showing small, semicircular eyes and large, anteriorly expanding, bulbous glabella. Occurrence: South shore of Hawkes Bay. Range: Forteau and Hawke Bay Formations (Labrador Group).
- Figure 7: *Olenellus brevoculus* Resser and Howell. Late Early Cambrian. Magnification: x 3, NFM F-60. Cephalon showing small, semicircular eyes; parallel-sided glabella; and anteriorly advanced left genal spine. Occurrence: South shore of Hawkes Bay. Range: Forteau Formation (Labrador Group).
- Figure 8: *Emania borealis* Howell. Late Middle Cambrian. Magnification: x 3, NFM F-61. Cranidium showing anteriorly tapering and rounded glabella; relatively wide, flat anterior border; left palpebral lobe and facial suture; and posterior areas of fixigenae. Occurrence: Green Island Cove. Range: March Point Formation (Port au Port group).



1



2



3



5



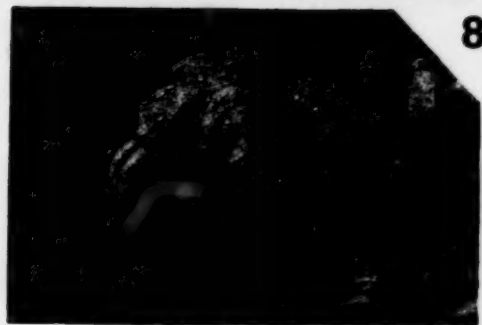
4



6



7



8

PLATE 9. TRILOBITES FROM THE MARCH POINT FORMATION.

Figures 1-4: *Ehmania borealis* Howell. Late Middle Cambrian. Magnification: Figure 1, x 3, NFM F-62; Figure 2, x 3, NFM F-63; Figure 3, x 3, G.S.C. 72982; Figure 4, x 4, NFM F-64. Figure 1: Cranidium showing anteriorly tapering and rounded glabella; relatively wide, flat anterior border; well developed furrows; and eye ridges. Occurrence: Green Island Cove. Figure 2: Cranidium showing posterior area of left fixigena and smooth surface ornamentation. Occurrence: Eddies Cove East. Figure 3: Cranidium showing facial sutures, and smooth surface ornamentation except for anterior areas of fixigenae, which possess well developed caecae. Occurrence: Eddies Cove East (specimen borrowed from C.H. Kindle). Figure 4: Pygidium oblong, showing well developed pleural and interpleural furrows, and smooth surface ornamentation. Occurrence: Eddies Cove East. Range: March Point Formation (Port au Port group).

Figure 5: *Ehmaniella* sp. cf. *E. waptaensis* Rasetti. Late Middle Cambrian. Magnification: x 6, NFM F-65. Cranidium showing anteriorly tapering and rounded glabella with well developed lateral glabellar furrows; smooth, convex-upward anterior border; strongly developed eye ridges; and well developed caecae in anterior areas of fixigenae. Occurrence: Eddies Cove East. Range: March Point Formation (Port au Port group).

Figures 6-8: *Ehmaniella cloudensis* (Howell). Late Middle Cambrian. Magnification: Figure 6, x 2, NFM F-66; Figure 7, x 25, NFM F-67; Figure 8, x 3, G.S.C. 72983. Figure 6: Cranidium showing anteriorly tapering and rounded glabella; strongly developed right eye ridge and palpebral lobe; posterior area of right fixigena; and well developed tuberculate surface ornamentation except for smooth, relatively wide, flat anterior border. Occurrence: Green Island Cove. Figure 7: Cranidium showing glabella with weakly developed lateral glabellar furrows and strongly developed eye ridges. Occurrence: Eddies Cove East. Figure 8: Cranidium showing posterior area of left fixigena. Occurrence: Eddies Cove East (specimen borrowed from C. H. Kindle). Range: March Point Formation (Port au Port group).

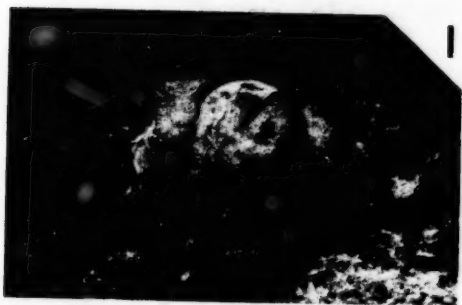


PLATE 10. TRILOBITES FROM THE MARCH POINT FORMATION.

Figures 1,2: *Emmaniella cloudensis* (Howell). Late Middle Cambrian. Magnification: Figure 1, x 3, NFM F-68; Figure 2, x 3.5, G.S.C. 72984. Figure 1: Nearly complete exoskeleton showing weathered tuberculate cranidium; thorax with 14 smooth thoracic segments; and pygidium. Occurrence: Green Island Cove. Figure 2: Pygidium, oblong, showing well developed pleural and interpleural furrows. Tuberculate surface ornamentation is present on the axial rings. Occurrence: Eddies Cove East (specimen borrowed from C.H. Kindle). Range: March Point Formation (Port au Port group).

Figures 3,4: *Kochina arctica* Poulsen. Late Middle Cambrian. Magnification: Figure 3, x 16, G.S.C. 72985; Figure 4, x 16, G.S.C. 72986. Cranidia showing anteriorly tapering and truncated glabella with well developed lateral glabellar furrows; weakly developed eye ridges; relatively straight and narrow convex-upward anterior border; posterior areas of fixigenae with deep posterior border furrows; outline of facial sutures; and strongly developed pustular and tuberculate surface ornamentation. Occurrence: Eddies Cove East (specimens borrowed from C.H. Kindle). Range: March Point Formation (Port au Port group).

Figures 5,6: *Elrathia* sp. cf. *E. quebecensis* Rasetti. Late Middle Cambrian. Magnification: Figure 5, x 6, G.S.C. 72987; Figure 6, x 8, G.S.C. 72988. Figure 5: Cranidium showing anteriorly tapering and rounded glabella without lateral glabellar furrows; weakly developed eye ridges and palpebral lobes; relatively wide, flat, poorly defined anterior border; posterior areas of fixigenae with well developed posterior border furrows; outline of facial sutures; and smooth surface ornamentation. A small, poorly defined occipital node or tubercle is present on the occipital ring. Figure 6: Cranidium showing glabella with very weakly developed lateral glabellar furrows, and better defined anterior border. A small, better defined occipital node or tubercle is present on the occipital ring. Occurrence: Eddies Cove East (specimens borrowed from C.H. Kindle). Range: March Point Formation (Port au Port group).

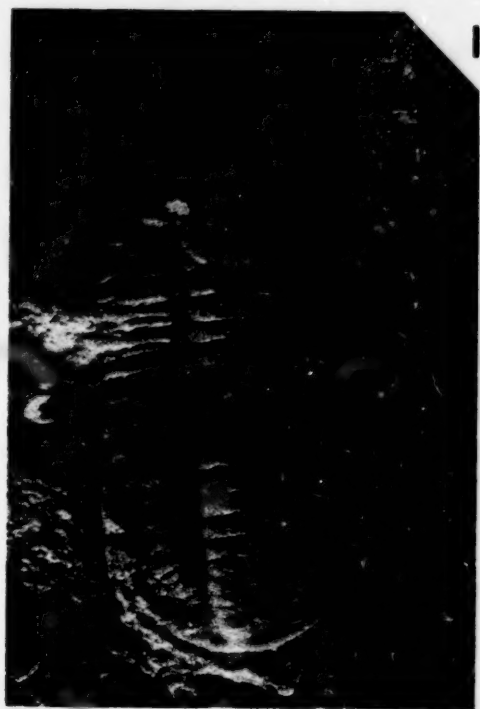


PLATE 11. TRILOBITES FROM THE MARCH POINT AND PETIT JARDIN FORMATIONS.

Figures 1,2,4: *Blainiopsis* sp. cf. *B. holtedahli* Poulsen. Late Middle Cambrian. Magnification: Figure 1, x 8, NFM F-69; Figure 2, x 9, NFM F-70; Figure 4, x 4, NFM F-71. Figure 1: Cranidium showing anteriorly tapering and rounded glabella with no lateral glabellar furrows; weakly developed eye ridges and large left palpebral lobe; narrow, convex-upward, well developed anterior border; posterior area of right fixigena with well developed posterior border furrow; outline of right facial suture; and finely granulose surface ornamentation. Figure 2: Pygidium incomplete, semicircular, showing five increasingly less defined axial rings posteriorly and well developed pleural furrows and posterior border. Figure 4: Pygidium nearly complete, showing finely granulose surface ornamentation. Occurrence: Eddies Cove East. Range: March Point Formation (Port au Port group).

Figure 3: *Asaphiscus* sp. cf. *A. laeviceps* (Walcott). Late Middle Cambrian. Magnification: x 8, NFM F-72. Cranidium showing anteriorly tapering and rounded glabella with no lateral glabellar furrows, extremely weakly developed right eye ridge, and relatively large, poorly defined right palpebral lobe; relatively wide, flat anterior border; posterior area of right fixigena with well developed posterior border furrow; outline of right facial suture; and finely punctate surface ornamentation. Occurrence: Eddies Cove East. Range: March Point Formation (Port au Port group).

Figures 5,6: *Arapahoa* sp.. Early Late Cambrian. Magnification: Figure 5, x 4, G.S.C. 72989; Figure 6, x 6, NFM F-73. Figure 5: Cranidium nearly complete, triangular, showing poorly defined, anteriorly tapering and rounded glabella with well developed occipital spine but no lateral glabellar furrows; small palpebral lobes; no anterior border; posterior area of left fixigena with well developed posterior border furrow; and outline of left facial suture (latex positive of specimen borrowed from C.H. Kindle). Figure 6: Pygidium oblong, showing weakly developed anterior pleural furrows and poorly defined anterior axial rings. Occurrence: Deadman's Cove. Range: Upper Dolostone Member - Petit Jardin Formation (Port au Port group).

Figures 7,8: *Blountia* sp.. Early Late Cambrian. Magnification: Figure 7, x 8, NFM F-74; Figure 8, x 6, NFM F-75. Figure 7: Cranidium showing anteriorly tapering and rounded glabella without lateral glabellar furrows and relatively wide, flat, weakly defined anterior border. Figure 8: Pygidium semicircular, showing weakly defined conical axial lobe and relatively wide, flat, weakly defined posterior border. Occurrence: Deadman's Cove. Range: Upper Dolostone Member - Petit Jardin Formation (Port au Port group).

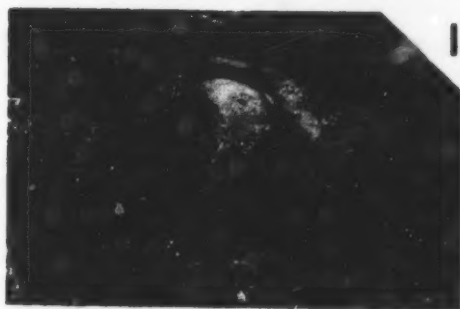


PLATE 12. TRILOBITES FROM THE PETIT JARDIN AND BOAT HARBOUR FORMATIONS.

Figures 1,2: *Terranovella* sp. cf. *T. obscura* Lochman. Early Late Cambrian. Magnification: Figure 1, x 8, NFM F-76; Figure 2, x 12, NFM F-77. Figure 1: Cranidium showing anteriorly tapering and rounded glabella with two pairs of weakly defined lateral glabellar furrows and well developed, but partially broken occipital spine; and strongly inflated, convex preglabellar area and fixigenae (specimen collected by C. Patey). Figure 2: Cranidium showing less rounded glabella with no occipital spine. Occurrence: Deadman's Cove. Range: Upper Dolostone Member - Petit Jardin Formation (Port au Port group).

Figures 3,4: *Coosella* sp. cf. *C. helena* Lochman. Early Late Cambrian. Magnification: Figure 3, x 12, NFM F-78; Figure 4, x 8, NFM F-79. Figure 3: Cranidium showing anteriorly tapering and rounded glabella without lateral glabellar furrows; well defined, narrow, convex-upward anterior border; and posterior area of left fixigena with well developed posterior border furrow. Figure 4: Pygidium showing weakly defined pleural furrows and wide, flat to concave-upward posterior border. Occurrence: Deadman's Cove. Range: Upper Dolostone Member - Petit Jardin Formation (Port au Port group).

Figures 5,6: *Hystericurus oculilunatus* Ross. Early Ordovician. Magnification: Figure 5, x 4, NFM F-80; Figure 6, x 6, NFM F-81. Figure 5: Cranidium showing anteriorly tapering and rounded, slightly bell-shaped glabella; well defined, narrow, convex-upward anterior border; posterior area of left fixigena with well developed posterior border furrow; and coarse tuberculate surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Figure 6: Pygidium semicircular, showing four well defined, wide pleural furrows; narrow, well defined posterior border; and coarse, tuberculate surface ornamentation with tubercles arrayed in pairs between the pleural furrows. Occurrence: Beach Point, Dog Peninsula, Brig Bay area. Range: Boat Harbour formation (St. George Group).

Figures 7,8: *Hystericurus* sp. nov.. Early Ordovician. Magnification: Figure 7, x 12, NFM F-82; Figure 8, x 16, NFM F-83. Figure 7: Cranidium showing straight-sided, anteriorly tapering and rounded glabella; well defined, narrow, convex-upward anterior border; posterior area of left fixigena with well developed posterior border furrow; and coarse tuberculate surface ornamentation. Note furrow in front of glabella joining preglabellar furrow with anterior border furrow. Figure 8: Pygidium oblong, showing four well defined axial rings with less prominent pair of tubercles on terminal ring compared to figure 6; well defined, narrow pleural furrows; almost nonexistent posterior border; and coarse tuberculate surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).



1



3



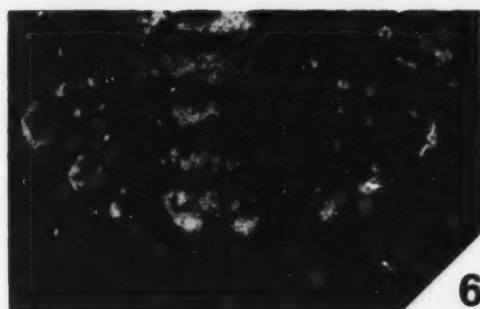
2



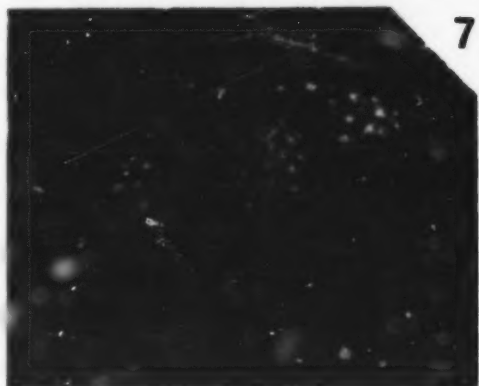
4



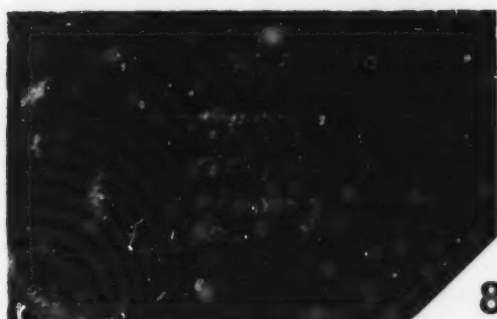
5



6



7



8

PLATE 13. TRILOBITES FROM THE BOAT HARBOUR AND CATOCHE FORMATIONS.

Figures 1,2: *Petigurus nero* (Billings). Early Ordovician. Magnification: Figure 1, x 3, NFM F-84; Figure 2, x 6, NFM F-85. Figure 1: Cranidium showing parallel-sided glabella; well defined right palpebral lobe and anterior section of right facial suture; posterior area of left fixigena and posterior section of left facial suture; and coarse tuberculate surface ornamentation. Occurrence: Port au Choix Peninsula. Figure 2: Pygidium subtriangular, showing five well defined axial rings including a bulbous terminal ring; strongly developed pleural furrows and incomplete interpleural furrows; almost nonexistent posterior border; and coarse tuberculate surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation and Catoche Formation (St. George Group).

Figure 3: *Ischyrotoma* sp.. Early Ordovician. Magnification: x 6, NFM F-86. Cephalon showing complete cranidium with parallel-sided glabella and characteristically attached librigenae, all with tuberculate surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Range: Catoche Formation (St. George Group).

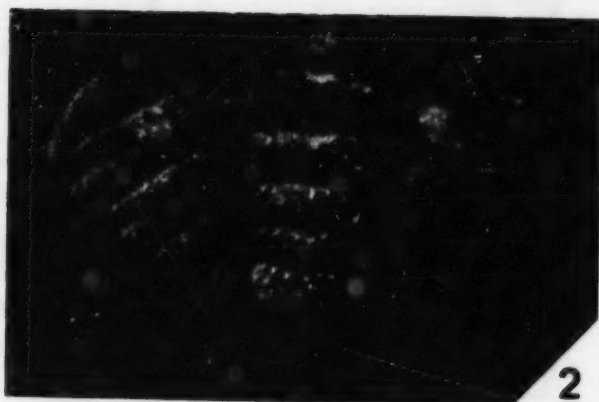
Figure 4: *Bathyrina* sp.. Early Ordovician. Magnification: x 6, NFM F-87. Pygidium semicircular, showing five increasingly less defined axial rings posteriorly; strongly developed pleural furrows but no interpleural furrows; well defined, narrow, concave-upward posterior border; and finely tuberculate or pustular surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour Formation and Catoche Formation (St. George Group).

Figures 5,6: *Parahystericurus* sp. nov.. Early Ordovician. Magnification: Figure 5, x 8, NFM F-88; Figure 6, x 8, NFM F-89. Figure 5: Cranidium showing elliptical glabella with weakly defined lateral glabellar furrows; well defined but extremely narrow anterior border; posterior area of left fixigena with well developed posterior border furrow; and finely pustular and tuberculate surface ornamentation. Figure 6: Pygidium oblong, showing four well defined axial rings; well defined pleural and interpleural furrows; and smooth surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).

Figures 7,8: *Hillyardina/Hyperbolochilus* sp. nov.. Early Ordovician. Magnification: Figure 7, x 6, NFM F-90; Figure 8, x 8, NFM F-91. Figure 7: Cranidium showing anteriorly tapering and rounded glabella with no lateral glabellar furrows; anterior border furrow; posterior areas of fixigenae with well developed posterior border furrows; and smooth surface ornamentation. Figure 8: Pygidium triangular, showing five well defined axial rings with a prominent pair of tubercles on terminal ring; well defined pleural and interpleural furrows; and smooth surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).



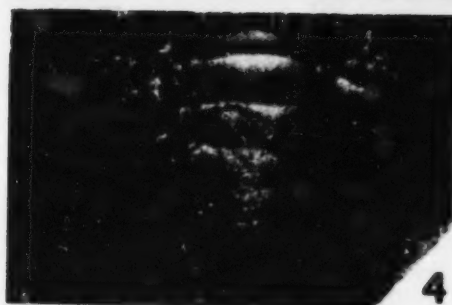
1



2



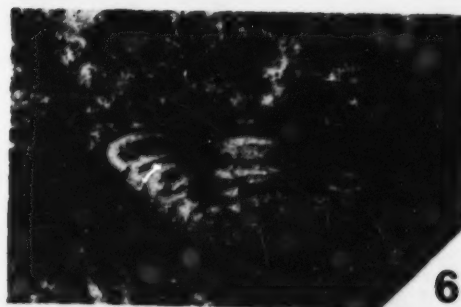
3



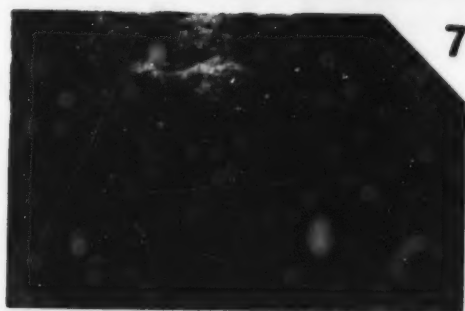
4



5



6



7



8

PLATE 14. TRILOBITES FROM THE BOAT HARBOUR AND CATOCHE FORMATIONS.

Figures 1,2: *Hillyardina/Hyperbolochilus* sp. nov.. Early Ordovician. Magnification: Figure 1, x 6, NFM F-92; Figure 2, x 6, NFM F-93. Figure 1: Librigena showing relatively wide but posteriorly tapering, concave-upward lateral border; narrow genal spine; and smooth surface ornamentation. Figure 2: Cranidium incomplete, showing wide, steeply sloping, vertical preglabellar area; and relatively wide, concave-upward anterior border; Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).

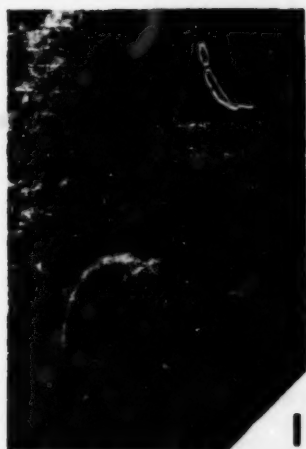
Figure 3: "*Parabellefontia*" sp. nov.. Early Ordovician. Magnification: x 6, NFM F-94. Nearly complete exoskeleton showing large, convex cranidium with glabella defined only weakly posteriorly; long, crescentic, undefined palpebral lobes but well defined anterior border; thorax composed of at least six long, narrow thoracic segments with well defined axial and pleural furrows; large, semicircular pygidium with only weakly defined, posteriorly tapering and rounded axial lobe; and wide, flat to concave-upward posterior border. Occurrence: Old Ferrolle Island, Brig Bay area. Range: Boat Harbour formation (St. George Group).

Figures 4,5: *Uromystrum affine* (Poulsen). Early Ordovician. Magnification: Figure 4, x 9, NFM F-95; Figure 5, x 3, NFM F-96. Figure 4: Cranidium generally featureless, but showing parallel-sided, anteriorly undefined glabella; well defined anterior border becoming undefined laterally; and smooth surface ornamentation. Figure 5: Pygidium large, wide, semicircular, generally featureless, but showing weakly defined, wide, concave-upward posterior border and smooth surface ornamentation. Occurrence: Boat Harbour section, Boat Harbour. Range: Catoche Formation (St. George Group).

Figures 6: *Bathyporellus abruptus* Billings. Early Ordovician. Magnification: x 4.5, NFM F-97. Cranidium showing parallel-sided, anteriorly rounded and weakly defined glabella; long, narrow, weakly defined, semicircular palpebral lobes; and weakly defined, wide, concave-upward anterior border. Occurrence: Port au Choix Peninsula. Range: Catoche Formation (St. George Group).

Figure 7: *Punka flabelliformis* Fortey. Early Ordovician. Magnification: x 3, NFM F-98. Pygidium large, wide, semicircular, showing posteriorly tapering and rounded axial lobe composed of six axial rings becoming progressively weakly defined posteriorly; the characteristic strongly developed pleural furrows; incomplete, more weakly developed interpleural furrows; and the weakly defined, extremely wide, convex-upward posterior border with terrace-lined surface ornamentation oriented roughly parallel to the posterior margin. Occurrence: Port au Choix Peninsula. Range: Catoche Formation (St. George Group).

Figure 8: *Isoteloides peri* Fortey. Early Ordovician. Magnification: x 6, NFM F-99. Cranidium triangular, relatively flat and essentially featureless, but showing tiny, weakly defined left palpebral lobe and characteristic outline of facial sutures. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation and Catoche Formation (St. George Group).



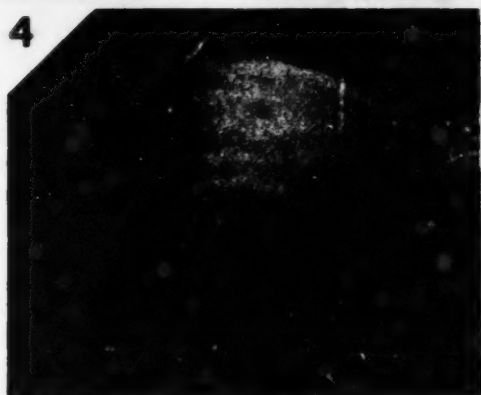
1



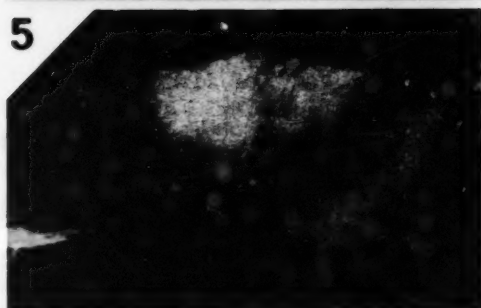
2



3



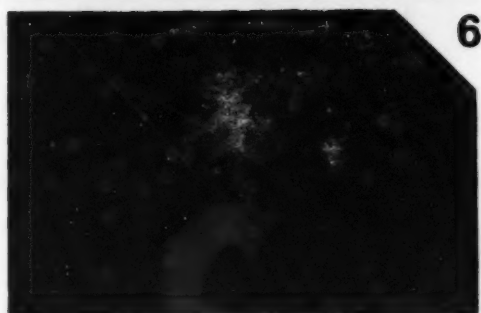
4



5



7



6



8

PLATE 15. TRILOBITES FROM THE BOAT HARBOUR AND CATOCHE FORMATIONS.

Figures 1,4: *Bathyurellus abruptus* Billings. Early Ordovician. Magnification: Figure 1, x 3, NFM F-100; Figure 4, x 3, NFM F-101. Figure 1: Pygidium showing characteristic duck-billed shape; small, conical, posteriorly rounded and weakly defined axial lobe; and flattened to slightly concave-upward postaxial region. Terrace-lined surface ornamentation is oriented perpendicular to the axial lobe in the postaxial region, but is convex anteriorly on the axial lobe itself. Figure 4: Librigena showing concave-upward, wide, but posteriorly tapering lateral border; genal spine; and characteristic terrace-lined surface ornamentation oriented roughly perpendicular to lateral margin. Occurrence: Port au Choix Peninsula. Range: Catoche Formation (St. George Group).

Figures 2,5: *Isoteloides peri* Fortey. Early Ordovician. Magnification: Figure 2, x 4, NFM F-102; Figure 5, x 4, NFM F-103. Figure 2: Pygidium semicircular and essentially featureless, but showing characteristic long, narrow, posteriorly tapering and abruptly rounded axial lobe consisting of numerous axial rings; extremely weakly defined pleural and interpleural furrows; and relatively narrow, weakly defined posterior border. Figure 5: Librigena showing characteristic outline of right facial suture; genal spine; and weakly defined, wide, concave-upward lateral border with terrace-lined surface ornamentation oriented roughly parallel to lateral margin. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation and Catoche Formation (St. George Group).

Figure 3: *Uromystrum affine* (Poulsen). Early Ordovician. Magnification: x 3, NFM F-104. Librigena showing genal spine and smooth surface ornamentation, but no lateral border. Occurrence: Boat Harbour section, Boat Harbour. Range: Catoche Formation (St. George Group).

Figures 6,7,8: *Paraplethopeltis seelyi* (Whitfield). Early Ordovician. Magnification: Figure 6, x 3, NFM F-105; Figure 7, x 6, NFM F-106; Figure 8, x 3, NFM F-107. Figure 6: Cranidium showing anteriorly tapering and rounded glabella with occipital ring and well defined, narrow, convex-upward anterior border. Occurrence: Eddies Cove West section, St. John Bay. Figure 7: Cranidium showing relatively long, wide, well defined, crescentic palpebral lobes with very poorly defined eye ridges; posterior area of left fixigena with well defined posterior border furrow; and outline of left facial suture. Occurrence: Moyrac Island, Brig Bay area. Figure 8: Pygidium oblong, showing posteriorly tapering and rounded axial lobe composed of four strongly defined axial rings; strongly developed pleural furrows; and well defined, narrow, concave-upward posterior border. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).

Figures 9,10: *Bolbocephalus convexus* (Billings). Early Ordovician. Magnification: Figure 9, x 4, NFM F-108; Figure 10, x 3, NFM F-109. Figure 9: Cranidium showing bulbous, anteriorly expanded and inflated glabella and posterior area of right fixigena with well developed posterior border furrow. Occurrence: Boat Harbour section, Boat Harbour. Figure 10: Pygidium convex, semicircular, showing posteriorly tapering, rounded and weakly defined axial lobe composed of five extremely poorly defined axial rings; and extremely poorly defined pleural and interpleural furrows. Occurrence: Port au Choix Peninsula. Range: Upper member - Boat Harbour formation and Catoche Formation (St. George Group).



1



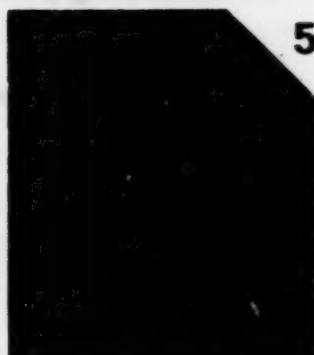
2



3



4



5



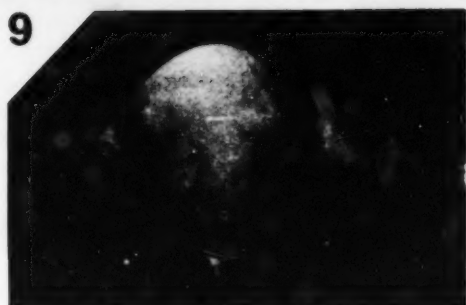
6



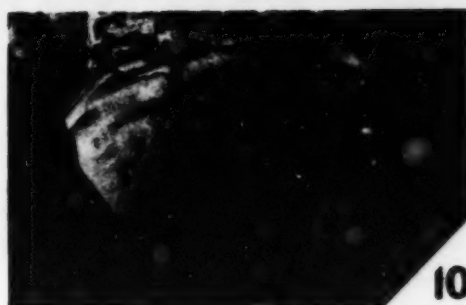
7



8



9



10

PLATE 16. TRILOBITES FROM THE BOAT HARBOUR AND CATOCHE FORMATIONS.

Figures 1,2: *Leiostegium* sp. nov.. Early Ordovician. Magnification: Figure 1, x 4, NFM F-110; Figure 2, x 6, NFM F-111. Figure 1: Cranidium showing parallel-sided and anteriorly rounded glabella; palpebral lobes; fixigenae with strongly defined posterior border furrows; and characteristic punctate surface ornamentation. Figure 2: Pygidium oblong, showing long, relatively narrow, posteriorly gently tapering and abruptly rounded axial lobe composed of at least eight axial rings becoming progressively less strongly defined posteriorly; strongly defined, relatively narrow, convex-upward posterior border; and characteristic punctate surface ornamentation. Occurrence: Eddies Cove West section, St. John Bay. Range: Upper member - Boat Harbour formation (St. George Group).

Figures 3,4,5: *Peltabellia* sp. nov.. Early Ordovician. Magnification: Figure 3, x 4.5, NFM F-112; Figure 4, x 3, NFM F-113; Figure 5, x 4, NFM F-114. Figure 3: Cranidium showing parallel-sided and anteriorly abruptly rounded and weakly defined glabella; well defined, narrow, circular palpebral lobes; fixigenae with well developed posterior border furrows; and facial sutures. Figure 4: Librigena showing posteriorly expanding, convex-upward lateral border; genal spine; and left facial suture. Figure 5: Pygidium semicircular, showing tapering and rounded axial lobe composed of at least four axial rings becoming progressively more weakly defined posteriorly; and characteristic strongly defined pleural furrows and well defined, wide, convex-upward posterior border lacking a posterior spine. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).

Figure 6: *Strigigenalis* sp. nov.. Early Ordovician. Magnification: x 6, NFM F-115. Pygidium showing posteriorly tapering and rounded axial lobe composed of at least four axial rings becoming progressively more weakly defined posteriorly; and characteristic weakly defined pleural and interpleural furrows, and well defined, wide, convex-upward posterior border with short posterior spine. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).

Figure 7: *Strigigenalis caudata* (Billings). Early Ordovician. Magnification: x 5, G.S.C. 72990. Pygidium showing posteriorly tapering and abruptly rounded axial lobe composed of at least four well defined axial rings; and characteristic pleural furrows becoming more weakly defined posteriorly, and poorly defined, wide, convex-upward posterior border with long posterior spine. Occurrence: Port au Choix Peninsula (specimen borrowed from C.H. Kindle). Range: Upper Member - Boat Harbour formation and Catoche Formation (St. George Group).

Figure 8: *Benthamaspis gibberula* (Billings). Early Ordovician. Magnification: x6, NFM F-116. Cranidium showing characteristic parallel-sided glabella with weakly defined occipital ring and anteriorly convex terrace-lined surface ornamentation; long, narrow, extremely weakly defined palpebral lobes; and fixigenae with very faint posterior border furrows. Occurrence: Port au Choix Peninsula. Range: Catoche Formation (St. George Group).

Figure 9: "*Parabellefontia*" sp. nov.. Early Ordovician. Magnification: x 3, NFM F-117. Librigena convex, showing posteriorly tapering, concave-upward lateral border; genal spine; and left facial suture. Occurrence: Boat Harbour section, Boat Harbour. Range: Upper member - Boat Harbour formation (St. George Group).

